

Site: Chevron Chemical
ID #: H00006272355
Break: 1, 2
Other: WWC
12-21-81

REPORT OF SUPPLEMENTAL GROUNDWATER EVALUATION
ORTHO-CHEVRON CHEMICAL COMPANY PLANT
MARYLAND HEIGHTS, MISSOURI

WOODWARD-CLYDE CONSULTANTS
5055 Antioch Road
Overland Park, Kansas
December 21, 1981 S81-5-2



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Site:	Chavon Chemical
ID #	MO-06272-255
Break:	L2
Other:	Wick
12-21-81	



WOODWARD-CLYDE CONSULTANTS

**CONSULTING ENGINEERS, GEOLOGISTS,
AND ENVIRONMENTAL SCIENTISTS**

CONFIDENTIAL

December 21, 1981
S81-5-2

Mr. Donald F. Searle, Project Manager
Environmental Control
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575 Market Street
San Francisco, California 94105

REPORT OF SUPPLEMENTAL GROUNDWATER EVALUATION
ORTHO-CHEVRON CHEMICAL COMPANY PLANT
MARYLAND HEIGHTS, MISSOURI

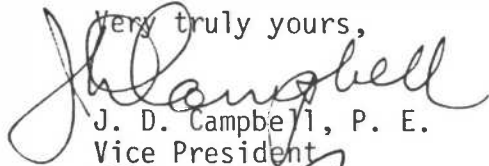
Dear Don:

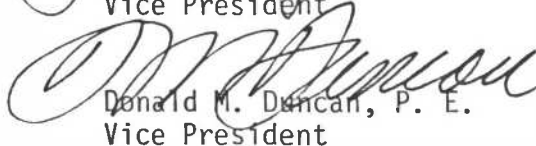
We are pleased to enclose this report of our investigation and evaluation of the groundwater quality at the Ortho-Chevron Chemical Company plant in Maryland Heights, Missouri. This report supplements our initial report entitled, "Report of Hydrogeologic Investigation and Groundwater Evaluation, Ortho-Chevron Chemical Company Plant, Maryland Heights, Missouri dated October 30, 1981." This report of site conditions was performed in general accordance with our proposal to you dated May 14, 1981 and as modified by our addendum of June 19, 1981.

We have documented the investigative tasks performed, presented the analytical test results and presented a discussion of our findings in this report. Recommendations have been provided for a continuing monitoring program.

This report has been prepared by Mr. Philip J. Knotts, Senior Staff Engineer, with the direction of the undersigned. Mr. Joe Kolmer has provided input and review for this work. Please contact us if you have questions or comments regarding this report.

Very truly yours,


J. D. Campbell, P. E.
Vice President


Donald M. Duncan, P. E.
Vice President

JDC:DMD:baf

enc.



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SUMMARY

This investigation of the groundwater quality at the Ortho-Chevron Company plant in Maryland Heights, Missouri was conducted in accordance with our recommendations to confirm and supplement the initial evaluation of the groundwater quality at the site. The initial evaluation was presented in Woodward-Clyde Consultants' report to Chevron dated October 30, 1981.

Three additional groundwater monitoring wells were installed at the site during this investigation which was conducted in July and August 1981. Groundwater levels were monitored and water samples were obtained for chemical analyses from these wells and from the fifteen wells installed during the previous site investigation. The analytical results for the groundwater samples obtained from the eighteen wells are presented in Appendix C. The distribution of the various groundwater contaminants around the site are presented in Figures 8 through 36.

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The analytical results confirm that groundwater entering the site from upgradient is relatively uncontaminated and that the area with the highest concentrations of organic pesticides is in the centrally located processing and handling area in the vicinity of wells OWC-6, OWC-7, OWC-8, OWC-10 and OWC-11. The apparent lack of continuity of measured concentrations between wells appears to indicate the presence of isolated individual contaminant sources rather than a single source.

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In comparing the February 1981 and August 1981 groundwater quality results, it is found that the number of organic pesticides detected and the concentrations of the pesticides were generally less in the August samples. This may indicate a general improvement in the groundwater quality at the

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site; however, additional water quality data would be required to statistically support this conclusion. Recommendations for a quarterly groundwater monitoring program to obtain the required data and to confirm the evaluation of the site are presented in this report.

The evaluation and management of surface water and potentially contaminated soil was outside the scope of this investigation. We understand that the storm water collection and drainage to the storm water surge pond has been improved. We also understand the nature of the soil/debris pile has been reviewed; based on this review and the EP toxicity test results the pile is considered non-hazardous.

Recommendations for the design of remedial work for the control of groundwater at the site was outside the scope of this project. If such work were required, we would be prepared to assist Chevron with the design and implementation of remedial works, continuation of groundwater monitoring, personnel training, reviews with regulatory groups, and additional site evaluations as appropriate.

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INTRODUCTION AND SCOPE OF WORK

This report presents the results of our investigation and evaluation of groundwater conditions at the Ortho-Chevron Chemical Company plant in Maryland Heights, Missouri. The field work was conducted in July and August of 1981 as authorized by the Chevron Chemical Company. The purpose of this investigation was to supplement and confirm the findings of our initial groundwater investigation which was part of our site investigation performed in January and February of 1981. The details of our initial site investigation are contained in the Woodward-Clyde Consultants' report titled, "Report of Hydrogeologic Investigation and Groundwater Evaluation, Ortho-Chevron Chemical Company Plant, Maryland Heights, Missouri," dated October 30, 1981.

Three groundwater monitoring wells were installed during the more recent investigation. Groundwater samples were obtained and analyzed from these wells and from the fifteen wells which were previously installed. The results from the chemical analyses of these water samples have been used to evaluate the concentrations of constituents in the groundwater and the potential magnitude and extent of contaminant migration.

SITE DESCRIPTION

The Ortho-Chevron Chemical Company plant is located in an established industrial area along Adie Road in Maryland Heights, Missouri, as shown in Figure 1. A general site plan showing the layout of the plant is shown in Figure 2. Surface elevations at the site vary from a high of approximately 540 at the east side of the site to elevation 510 at the west. Surface

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drainage is generally to the west/northwest and a well defined but intermittent drainage way flows from the south to the north near the west end of the site. The plant is located in a drainage basin which is a tributary to FeeFee Creek which in turn is a tributary to the Missouri River. A small storm water retention pond is located near the northwest corner of the site.

We understand that the Ortho-Chevron Chemical Company has been operating at this site for approximately twenty-five years and that production processes at the plant are generally limited to formulating and packaging organic pesticides. Raw materials and finished goods are shipped to and from the site by rail and truck.

Based on our previous investigations at this site and conversations with plant personnel, we understand that leaks and spills of pesticides and carrier products have occurred in the past. We also understand that past practice may have called for on-site disposal of certain waste materials including the burial of debris from an old fire.

A sanitary landfill and fertilizer plant are located adjacent to and hydraulically upgradient from the Ortho-Chevron plant; see Figure 1.

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Analytical results from our previous investigation did not indicate any substantial effects from these adjacent facilities on the groundwater entering the Ortho-Chevron property.

use of these wells

The results from a field survey, a search of records, and personal interviews indicate that no shallow water supply wells exist within one-quarter mile of the plant. Six wells were located in Sections 23 and 26, Township 46 North, Range 5 East. These wells vary in depth from

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140 feet to 325 feet, penetrate into the bedrock, and are beyond one-quarter mile from the plant. Available details for these wells were presented in our initial report. The well locations are shown on Figure 1.

FIELD INVESTIGATION

Exploratory Borings

Three borings were drilled at the locations designated OWC-16, OWC-17, and OWC-18, as shown on the site plan, Figure 2. The borings were advanced to depths of up to 76 feet using a truck-mounted drill rig. Soil samples were obtained at selected depths by hydraulically pushing a 2-inch-ID liner-tube sampling device. Samples of the rock encountered at the site were obtained from boring OWC-18 using an NX-size double-tube core barrel.

The borings were located in the field based upon the topographic map provided by Ortho-Chevron and were drilled under the supervision of Woodward-Clyde Consultants' geologist. Grade elevations at the boring locations were surveyed by Woodward-Clyde Consultants using the established bench marks located on the site. Elevations of ground surface and changes in soil strata are rounded to the nearest foot.

The eight soil samples obtained during the investigation were returned to our office and extruded at the end of the day. The samples were placed in glass jars which had been previously rinsed with an organic solvent (acetone) to prevent outside contamination. In the event that future examination of these samples is required, the samples are being stored under refrigeration at our St. Louis office. The samples will be stored with the samples obtained during the initial investigation until our

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services are terminated after which all samples will be relinquished to Ortho-Chevron.

Logs of the borings were prepared based upon observations of the auger cuttings, drilling characteristics, and recovered samples. The logs were subsequently modified as necessary based on laboratory examination of the samples as they were extruded. The detailed boring logs are presented in Appendix A. Our graphic interpretation of the boring logs from this investigation and the previous investigation is presented in Figures 3 through 6.

The general subsurface profile consists of up to 8 feet of fill at the surface overlying 15 to 20 feet of stiff, brown, silty clay (loess). Underlying the loess is approximately 5 feet of highly plastic residual clay and beneath the clay is shale. The thickness of the shale is quite variable and in some places the shale is completely weathered to clay. Limestone was encountered beneath the shale at depths ranging from approximately 30 to 70 feet. Borings OWC-16 and OWC-17 were completed in the highly plastic residual clay. Boring OWC-18 penetrates 46 feet into the limestone which was encountered at a depth of 30 feet.

Observation Well Installations

Each of the three exploratory borings were completed as groundwater observation wells. Details of the individual well installations are summarized in Table 1. Individual well profiles are presented in Appendix B.

Borings OWC-16 and OWC-17 were advanced with an 8-inch-diameter continuous-flight auger and were completed as shallow borings at depths of

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less than 20 feet. Boring OWC-18 was advanced with an 8-inch-diameter continuous-flight auger down to bedrock where the boring was continued by rock coring. After the coring was completed, the boring was cased down to bedrock to prevent caving and a 6-inch-diameter roller bit was used to ream out the core hole.

Because well OWC-18 was drilled into the limestone, potable water was pumped into the boring to cool the core barrel and subsequently to remove the cuttings resulting from reaming the core hole. The water was recirculated from a steel tank. Bentonite mud was not used.

Well OWC-18 has a 2-inch-diameter casing which extends to a depth of 76 feet. The lower 20 feet of the well is screened. The top of the screen is approximately 26 feet below the soil/limestone contact. The top of the 10-foot-thick bentonite clay-pellet seal, which was poured above the top of the screen, is 9 feet below the soil/limestone contact. A cement-bentonite grout was poured in the annular space above the bentonite seal. The limestone is gray and weathered with horizontal and vertical fractures and chert zones. The limestone appears to become less weathered and less fractured with depth. Groundwater recharges to the well relatively slowly and we were able to bail this well essentially dry with a 4-foot-long, 3/4-inch-OD PVC bailer.

While the borings were being drilled, the slotted PVC well screen sections and the solid PVC riser pipe sections were joined together. A PVC cap was placed on the bottom of the well screen. The pipe was then hoisted by the drill rig and lowered into the boring immediately after the borings had been completed.

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Clayey sand was poured into the annular space around the well screen to sufficiently fill the annular space to a depth of approximately 2 feet above the top of the screen. Bentonite clay pellets were poured into the annular space to form a 3-foot-thick clay seal above the sand in wells OWC-16 and OWC-17 and a 10-foot-thick clay seal in well OWC-18. A cement-bentonite grout was pumped into the annular space from the top of the bentonite pellet seal to within approximately 2 feet of the surface. Concrete was added to the remaining annular space and a 6-inch-diameter steel pipe was placed over the well and set into the concrete. Each well has a vented PVC cap and each protective casing is provided with a drain hole which is approximately 4 inches above the existing grade.

A $\frac{1}{4}$ -inch-thick, 2-inch-wide steel bar was inserted into slots on either side of the protective casing and padlocked to prevent unauthorized entry to the wells. The protective casings were painted black and can be identified by the alpha-numeric designations stenciled on each protective casing. The wells can be further identified by the press-apply number glued to each well cap.

Development of Observation Wells

Each well was bailed several times after installation in order to develop the wells. Recharge to the wells was relatively slow and each well was bailed essentially dry during development.

Wells OWC-16 and OWC-17 are 4 inches in diameter and well OWC-18 is 2 inches in diameter. To prevent cross contamination of the wells, individual bailers were hung in the 4-inch-diameter wells. The bailers are approximately 4 feet long with an inner diameter of 2.5 inches and have a

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capacity of approximately 1 gallon. The bailers were initially constructed and cleaned in our laboratory, individually sealed in plastic, and transferred to the site.

GROUNDWATER SAMPLE COLLECTION

As recommended by the Missouri Department of Natural Resources (1979), in preparation for sampling each well was flushed (i.e., bailed dry or a volume of water equivalent to a minimum of three to five times the casing volume was removed) and the well allowed to recharge prior to sampling. To evaluate the hydraulic gradient of the groundwater, the depth to groundwater was measured in each well prior to flushing and sampling. These groundwater elevations are presented in Table 2. A groundwater contour map interpreted from the observed groundwater wells is presented as Figure 7. These elevations are consistent with previously measured groundwater elevations as presented in Table 3.

At the time of sampling the following groundwater parameters were measured in the field: pH, specific conductivity, and temperature. Results of these field tests are presented in Table 4.

The following samples were obtained from each of the fifteen existing wells and the three newly installed wells. The sample containers included one small glass vial for total organic carbon (TOC), three 1-liter glass bottles for organic analyses, one plastic quart container for metals analyses, and one plastic quart container for general water quality analyses.

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At each well, from the first bailer of water, a small quantity of water was used to rinse the TOC vial and the vial was then filled. A large-mouthed plastic bottle used for the field analysis was rinsed and filled; the remaining water in the bailer was used to rinse the three glass bottles and two plastic containers. The second bailer of water was then drawn and an approximately equal aliquot of water was poured into each sample bottle. This procedure continued until each bottle was full. The samples were then immediately placed on ice and remained on ice through shipment to the laboratory. Samples were shipped daily via bus to the analytical laboratory for analyses.

The samples for organic analyses were filtered through 1.0-micron-pore-size glass-fiber filters at Wilson Laboratories prior to analyses. The samples for metals analyses were filtered through 0.45-micron-pore-size filters and acid preserved in accordance with EPA Publication 600-4-79-020 Methods for Chemical Analyses of Water and Wastes. The samples were filtered to remove suspended solids which are normally not transported by groundwater.

LABORATORY TESTING

The groundwater samples were analyzed by Wilson Laboratories for the organic pesticides and metals listed in Table 5 and for total organic carbon, and general water quality parameters. The distribution of each major parameter analyzed in the groundwater samples obtained in February and August, 1981, is presented in Figures 8 to 36. The complete results of water quality analyses performed on the August set of groundwater samples

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are presented in Appendix C. Results of the organic analyses and selected inorganic analyses for the August samples are summarized in Table 6. EPA Drinking Water Standards and Missouri Groundwater Recharge Standards are shown for comparison. *AWPC*

DISCUSSION OF RESULTS

Chemical analyses of the samples obtained from the eighteen monitoring wells on site indicate the concentrations of pesticides in the groundwater vary widely depending upon the location and depth of the wells. There appear to be four inter-related areas of groundwater quality at the site. For the purposes of this discussion, these areas are defined by the groundwater quality as measured in the samples obtained from the shallow wells at the eastern, central and western portions of the site and by the groundwater quality as measured in the samples obtained from the three deep wells at the site. A discussion of the general water quality in each of these areas is presented below.

East Plant Area

See map
The wells included in this area of the site are OWC-1, OWC-3, OWC-9, and OWC-16. With the direction of the groundwater movement toward the north-northwest as shown in Figure 7, wells OWC-1, OWC-3, and OWC-9 are generally upgradient from the plant activities. Lindane and 2,4,5-T were detected in well OWC-1. Lindane was the only pesticide detected in well OWC-3. Lindane, dieldrin, 4,4-DDT, 4,4-DDE, and 4,4-DDD were detected in well OWC-9. The concentrations of each of these pesticides were less than 1 part per billion (ppb). For this discussion, parts per billion (ppb) and

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parts per million (ppm) will generally be used instead of micrograms ^{ug/l} per liter and milligrams ^{mg/l} per liter, respectively. See Glossary for specific definition of terms.

Lindane, heptachlor, dieldrin, diazanon, 2,4,5-T, and 2,4-D were detected in well OWC-16 at concentrations less than 4 ppb. This well is immediately downgradient from the north rail spur. The source of pesticides detected in the groundwater at this location may be leaks and spills from the tank cars which are unloaded in this area.

Analysis of general water quality parameters from the upgradient wells, OWC-1, OWC-3, and OWC-9, continue to indicate no significant effects on the groundwater entering the site due to the landfill and fertilizer plant located hydraulically upgradient. Arsenic, which is the primary inorganic constituent of concern at the site, was non-detected in wells OWC-1 and OWC-3 and ranged from .004 parts per million (ppm) in well OWC-9 to .014 ppm in well OWC-16.

Central Plant Area

The shallow wells included in this area of the plant are OWC-6, OWC-7, OWC-8, OWC-10, OWC-11, and OWC-17. Lindane was detected in the samples from each of these wells at concentrations ranging from approximately 6 ppb in well OWC-6 to 410 ppb in well OWC-7. Other pesticides, including

As a component of pesticides - other sources?

6-410 PPB Lindane

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Lindane, detected in the water samples obtained from the wells in the central plant processing area include:

<u>Pesticide</u>	<u>Range of Concentrations (ppb) except as noted</u>	
Lindane	less than 6	- 410
2,4-D	less than 1	- 1,600
2,4,5-T	less than .1	- 435
4,4-DDD	less than .2	- 12.3
4,4-DDE	less than .2	- .19
4,4-DDT	less than .3	- 8.8
Aldrin	less than .2	- 26
Diazanone	less than .5	- 8.7
Dieldrin	less than .2	- 22
Heptachlor	less than .2	- 2.43
Malathion	less than 1	- 4.1
Arsenic	less than .012(ppm) - .80(ppm)	

In general, the groundwater samples obtained from wells in the central processing area had the largest number of organic pesticides and the highest pesticide concentrations. However, the general lack of continuity of detectable organic pesticides between wells indicates that isolated individual sources of contamination may exist rather than a single source.

West Plant Area

The shallow wells located in the west plant area are OWC-4, OWC-5, OWC-13, OWC-14, and OWC-15. Lindane was the only organic pesticide detected in wells OWC-14 and OWC-15. No organic pesticides were detected in the sample obtained from well OWC-4. The concentrations of the three organic pesticides detected in the sample from OWC-5 were less than 2 ppb. Six organic pesticides were detected in well OWC-13. However, the

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concentrations were less than 4 ppb with the exception of Lindane which was relatively at high 234 ppb.

With the northwesterly movement of the groundwater, well OWC-4 is upgradient of the west plant area and should be unaffected by the plant operations. The general lack of organic pesticides in wells OWC-14 and OWC-15 which are downgradient from the site may indicate that the groundwater in this area has not been significantly affected by plant operations including seepage from the storm water retention pond. The organic pesticides detected in the groundwater in the vicinity of wells OWC-5 and OWC-13 may indicate isolated individual sources of contaminants near these wells and/or the movement of pesticides in the groundwater from the central plant processing area.

The concentrations of arsenic in the groundwater samples obtained from the west end were also very low (less than .001 to .002 ppm).

Deep Wells

There are three wells at the site which penetrate into limestone, OWC-2, OWC-12 and OWC-18. Well OWC-2 is located at the east end of the site and is upgradient from the plant facilities. The well has 10 feet of screen, 8 feet of which penetrate into the limestone and 2 feet which extend above the limestone into the shale. The limestone encountered in this boring was massive and relatively unweathered and unfractured.

what depths of OWC do these wells meet?

Lindane was the only organic pesticide detected in this well (.23 ppb) and arsenic was just barely detectable (.001 ppm).

Well OWC-12 is located in the central plant processing area. This well has 10 feet of screen, 8 feet of which penetrate into the limestone,

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well #12
with 2 feet extending above the limestone into clay. The limestone encountered in this boring was fractured with several weathered zones encountered within the top 4 feet. Nine organic pesticides were detected in the groundwater sample obtained from this well at concentrations ranging from .25 to 67 ppb. The concentration of arsenic in the sample was .019 ppm.

Well OWC-18 is located in the west/central plant area. This well penetrates 46 feet into the limestone with the lower 20 feet of the well screened. The limestone encountered in this boring was relatively weathered with horizontal and vertical fractures. Eight organic pesticides were detected in the groundwater sample obtained from this well. With the exception of Lindane at 58 ppb, the concentrations of the other pesticides were less than 2 ppb. The concentration of arsenic was .03 ppm.

Groundwater Trends

1. Arsenic at less than .001 to .80 ppm continues to be the primary inorganic constituent of concern. During both sampling periods the highest concentrations in the groundwater were detected in samples obtained from wells located in the central plant processing area.

2. The most frequently detected organic pesticides in the groundwater were Lindane, 2,4,5-T, Dieldrin, and 2,4-D.

→o Lindane was detected in seventeen of the eighteen wells sampled in August. The concentrations of Lindane ranged from .15 to 410 ppb.

→o 2,4,5-T was detected in ten of the eighteen wells sampled. The concentrations of 2,4,5-T ranged between .22 and 435 ppb.

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- 0 Dieldrin was detected in nine of the eighteen observation wells sampled and ranged in concentrations from .27 to 22 ppb.
- 0 2,4-D was detected in eight of eighteen observation wells with concentrations ranging from 1.1 to 1,600.

In general, the wells with the highest concentrations and most frequently detected organic pesticides were the wells located in the central plant processing area.

3. The presence of organic pesticides in wells OWC-16 and OWC-17 may indicate the potential movement of pesticides across the north property line.

4. Groundwater samples analyzed from the upgradient wells continue to indicate no significant effect on the groundwater entering the site due to the landfill and fertilizer plant located upgradient.

5. The August groundwater samples indicate a general improvement in groundwater quality as compared to the water quality determined from the February samples. The number of organic pesticides detected in the samples obtained from each well in August, was generally less than the number detected in samples obtained from each well in February. Also, the concentrations of the pesticides which were detected were generally lower in the August samples. However, a larger volume of water quality data is required to perform a meaningful statistical analysis of any trends in groundwater quality.

6. Additional flushing and sampling of the deep wells, in particular wells OWC-12 and OWC-18, will be required to establish whether the pesticides detected in these initial samples are moving within limestone or

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*Potential
contaminant
leakage from
limestone aquifer
into of aquifer?*

were introduced during the drilling process or are a result of local recharge from the overlying loessial soils to the deep well through the fractured limestone.

POTENTIAL CONTAMINANT MIGRATION

Figure 7 shows the groundwater contour map interpreted from the groundwater levels observed during August, 1981. Water levels indicate the general direction of flow is to the north/northwest with an average gradient across the site of approximately 0.025 foot per foot. The water levels observed in August were slightly higher than those observed in February and indicate a slight northerly shift in the direction of groundwater movement and a slight increase in hydraulic gradient from the 0.021 foot per foot observed in February. *www*

Using the gradient observed in August, the estimated soil permeability of 1 foot per day, and assuming a soil porosity of 30 percent, the velocity of the pore water in the soil is estimated to be much less than 1 foot per day. Assuming these are average conditions, we estimate the groundwater would flow approximately 500 to 1000 feet in twenty-five years toward the north/northwest. At this rate contaminants in the groundwater might have moved a maximum of approximately 15 to 20 feet during the elapsed time between the February and August sampling periods. Using the water levels observed in August and assuming a contaminant plume width of approximately 200 feet, the groundwater flow rate would be estimated at about 800 gallons per day across an imaginary boundary 200 feet wide. *10-20 feet*

These estimates of groundwater flow are based on (1) average site conditions as estimated from the information obtained during this investigation, and (2) the assumption that the average conditions are uniformly representative across the site. The actual conditions at any location on the site will vary from the estimated average conditions, and we expect that our estimates will change as additional information about the site conditions becomes available. Using the maximum permeability measured during this investigation, the distance traveled by the groundwater would be increased by a factor of three (i.e., 1500 to 3000 feet).

The actual rate and quantity of pesticide movement in the groundwater is mitigated by soil attenuation. The silty clay soil at this site has a high affinity for organic pesticides and the rate of groundwater movement is probably sufficiently slow to allow some sorption of pesticides onto the soil particles as the water flows through the soil.

The contaminant flux or mass flow rate of the pesticides is a function of the groundwater flow rate, concentration of the pesticides, and the sorption potential of the soil through which the water flows. Because of the apparent isolated individual sources of contaminants, a mean pesticide concentration was estimated from the concentrations of all detected organic pesticides in the wells where the higher concentrations were measured (i.e., OWC-6, OWC-7, OWC-10, OWC-11, OWC-12, and OWC-17). The average concentration of organic pesticides in the groundwater in the central processing area is 79 ppb. Using this average concentration, we estimate the net organic pesticide contaminant loading may be less than 1 gram per

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day. An example of the approach used to determine the contaminant loading or flux is presented in Appendix D.

As an alternative method of evaluating the mass flow rate of pesticides, values of total organic carbon (TOC) were averaged for the same wells as described above. This average concentration is higher and, therefore, more conservative than the estimated mean pesticide concentration because total organic carbon includes the organic pesticides, the organic carrier materials, and other miscellaneous organics in the groundwater. The average concentration for total organic carbon is 86 ppm for the samples collected in August 1981. Using this average concentration for TOC, the net contaminant loading may be less than 300 grams per day. The average concentration for total organic carbon estimated from the February data was 46 ppm.

The corresponding average pesticide concentration estimated from the February data was 160 ppb and the average concentration for total organic carbon estimated from the February data was 46 ppm. The estimated loadings from the February groundwater quality data for detected pesticides and TOC were less than 1 gram per day and less than about 100 grams per day, respectively.

These estimates of contaminant flux are based on the groundwater flow estimates discussed above and the average concentrations of pesticides and total organic carbon from a limited number of groundwater samples. We expect our estimates of contaminant flux will change as additional information about the actual site conditions becomes available. The installation of additional wells, additional sampling and chemical analyses

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including permeability testing could indicate anomalies at the site, which would significantly affect our estimates of groundwater flow and contaminant flux.

RECOMMENDATIONS

Based on our field investigation, laboratory analyses, and our prior experience, we recommend that groundwater quality monitoring continue on a quarterly basis but with a reduced scope of sampling and testing.

We recommend that wells OWC-6, OWC-7, OWC-10, OWC-11, OWC-12, OWC-16, OWC-17 and OWC-18 be sampled on a regular basis in the future. We recommend that the samples be analyzed by a certified analytical laboratory for the organic pesticides listed in Table 5 and for Arsenic, Total Organic Carbon, pH, and Specific Conductivity. A Priority Pollutant Scan of gold groundwater samples obtained during the next sampling period from wells OWC-11 and OWC-17 is appropriate to determine whether the proposed list of chemical constituents may need to be expanded to include other previously unrecognized problem constituents.

The additional water quality data may then provide a statistical basis to quantitatively evaluate:

- o the rate of pesticide movement
- o long-term trends in groundwater quality, flow rates, and contaminant trends with time
- o the impacts of remedial measures or changes in plant operations which might affect groundwater quality

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We are prepared to assist Ortho-Chevron with the development and implementation of the recommended reduced sampling plan including training Ortho-Chevron personnel in groundwater sampling techniques.

We will be pleased to discuss these recommendations with you and develop a work program to implement these recommendations as you desire.

LIMITATIONS

Boring logs depict subsurface conditions for the indicated locations and dates. With the passage of time changes in subsurface conditions may occur, especially with respect to groundwater. The depth to groundwater and groundwater quality will vary with time and space. We request the opportunity to re-evaluate the site conditions and our interpretations relative to the design or implementation of any remedial measures if a significant time interval has elapsed from the date of this study.

GLOSSARY

Part per million, ppm - a measure of proportion by weight, equivalent to a unit weight of solute per million (10^6) unit weights of solution.

Part per billion, ppb - a measure of proportion by weight, equivalent to a unit weight of solute per billion (10^9) unit weights of solution.

Note - A part per million is generally considered equivalent to a milligram per liter and a part per billion is generally considered equal to a microgram per liter, but this is not precise. For example, a part per million is equivalent to a milligram of solute per kilogram of solution.

Milligram per liter, mg/l - a weight-volume measurement which expresses the concentration of a solute in milligrams (10^{-3} grams) in a liter of solution.

Microgram per liter, ug/l - a weight-volume measurement which expresses the concentration of a solute in micrograms (10^{-6} grams) in a liter of solution.

Micron, um - a micron is a unit of length; 1 micron equals 10^{-6} meters (0.000001 meters). When used to describe a filter membrane, such as 0.45 micron pore-size membrane, the length refers to the nominal pore diameter.

TABLE 1

OBSERVATION WELL INSTALLATION DETAILS

<u>Well Designation</u>	<u>Elevation of Protective Casing (feet)</u>	<u>Elevation of Ground Surface* (feet)</u>	<u>Casing Diameter (inches)</u>	<u>Well Depth (feet)</u>	<u>Depth Over Which Well is Screened or Sand Packed**</u>	<u>Screen Slot Width (inches)</u>
OWC-1	543.7	541	4	23	10.5 - 23.0	0.02
OWC-2	542.3	541	1.5	69.5	56.5 - 69.5	0.03
OWC-3	532.0	529	4	35	13.0 - 35.0	0.02
OWC-4	521.4	519	4	29.5	8.5 - 29.5	0.02
OWC-5	518.1	515	4	25	12.0 - 26.5	0.02
OWC-6	525.6	523	4	25	7.0 - 26.5	0.02
OWC-7	525.3	523	4	17	4.5 - 17.0	0.02
OWC-8	525.7	523	4	27.5	16.5 - 27.5	0.02
OWC-9	534.8	532	4	32	9.5 - 32.0	0.02
OWC-10	530.1	528	4	28	10.0 - 28.0	0.02
OWC-11	526.2	524	4	28	16.0 - 28.0	0.02
OWC-12	526.5	524	1.5	40.3	28.25 - 40.25	0.03
OWC-13	518.8	516	4	20	8.0 - 21.5	0.02
OWC-14	515.0	513	4	22	9.0 - 23.5	0.02
OWC-15	516.5	514	4	20	8.0 - 21.5	0.02
OWC-16	524.2	523	4	19	7.0 - 19.0	0.02
OWC-17	524.9	521	4	18	6.0 - 18.0	0.02
OWC-18	521.3	519	2	76	49.0 - 76.0	0.03

* Rounded to nearest foot

** The lower portion of the well is screened. The sand pack around the screen generally extends 2 to 3 feet above the top of the screen. Refer to Appendix B for individual well profiles.

Elevations based on USC & GS datum.

TABLE 2
FLUSHING AND SAMPLING OF OBSERVATION WELLS
JULY - AUGUST 1981

<u>Well</u>	<u>Date Flushed</u>	<u>Water Elevation Prior to Flushing</u>	<u>Date Sampled</u>	<u>Water Elevation Prior to Sampling</u>
OWC-1	7/21/81	538.5	7/22/81	536.8
OWC-2	7/21/81	508.0	7/22/81	493.3
OWC-3	7/21/81	525.4	7/22/81	525.4
OWC-4	7/22/81	515.3	7/22/81	514.9
OWC-5	7/20/81	512.2	7/21/81	512.1
OWC-6	7/22/81	518.0	7/22/81	518.0
OWC-7	7/21/81	518.3	7/22/81	518.2
OWC-8	7/21/81	518.9	7/22/81	518.6
OWC-9	7/21/81	530.3	7/22/81	529.7
OWC-10	7/21/81	523.8	7/22/81	523.4
OWC-11	7/20/81	517.4	7/21/81	517.4
OWC-12	7/20/81	517.2	7/21/81	517.2
OWC-13	7/20/81	513.7	7/21/81	513.7
OWC-14	7/20/81	509.4	7/21/81	507.5
OWC-15	7/20/81	509.1	7/21/81	509.1
OWC-16	8/10/81	521.6	8/10/81	521.6
OWC-17	8/10/81	515.6	8/10/81	514.9
OWC-18	8/10/81	513.7	8/10/81	474.3

USC & GS elevation datum.

TABLE 3
OBSERVED GROUNDWATER LEVELS
USGS Elevation (feet)

Well No.	February 1981													March 1981			July 1981			August 1981				
	9	12	13	16	17	18	19	20	21	23	24	25	26	27	11	17	19	20	21	22	4	7	10	
OWC-1	-	-	-	-	-	-	533.6	534.4*	-	537.8	537.8	-	537.5	537.2	537.6	537.6	537.4	538.5	-	536.8*	-	-	-	
OWC-2	-	-	-	-	-	-	-	-	-	539.3	-	486.2*	482.8*	483.5*	488.2	490.6	491.5	508.0	-	493.3*	-	-	-	
OWC-3	-	-	-	-	523.0	522.3*	-	522.1	-	522.3	522.5	-	522.3	522.5	522.8	522.7	522.5	525.4	-	525.4	-	-	-	
OWC-4	-	-	-	-	513.2	513.1*	-	512.6	-	513.1	513.0*	-	-	512.5	512.0	511.3	510.8	515.3	-	514.9*	-	-	-	
OWC-5	509.8	509.5	509.1*	510.2	-	-	510.6	-	-	510.6	510.3	510.6*	-	510.6	-	511.1	510.8	512.2	512.1*	-	-	-	-	
OWC-6	515.8	516.2	516.2*	517.5	-	517.4	-	-	-	517.4	517.3*	-	-	517.1	517.1	516.9	516.8	518.0	-	518.0	-	-	-	
OWC-7	-	-	-	-	-	-	-	517.7	517.5*	517.8	517.5*	-	-	517.7	517.8	517.8	517.7	518.3	-	518.3	-	-	-	
OWC-8	-	-	-	-	-	-	-	-	518.9	518.4	518.3*	-	-	518.2	518.4	518.4	518.2	518.9	518.9	518.6*	-	-	-	
OWC-9	-	529.1	529.1*	-	529.6	529.8	-	-	-	529.8	529.6*	-	529.1	529.3	529.8	529.7	529.7	530.3	-	529.7*	-	-	-	
OWC-10	-	-	-	523.3	-	523.5	-	-	-	523.4	523.0*	-	-	522.8	523.1	523.4	523.2	523.8	-	523.4*	-	-	-	
OWC-11	-	-	-	-	-	-	-	516.8	516.8*	517.1	517.0*	-	-	516.7	-	516.7	516.5	517.4	517.4	-	-	-	-	
OWC-12	-	-	-	-	-	-	-	-	-	516.7	516.7*	516.6	516.6*	516.6	516.9	516.8	516.7	517.2	517.2	-	-	-	-	
OWC-13	512.8	512.4	512.5*	513.0	-	-	513.5	-	-	513.3	513.1	513.4*	-	513.3	513.5	513.6	513.3	513.7	513.7	-	-	-	-	
OWC-14	505.2	-	505.9*	508.9	-	-	509.2	-	-	509.4	509.2	507.5*	-	508.9	509.4	509.3	509.2	509.4	507.5*	-	-	-	-	
OWC-15	504.8	504.2	504.4*	504.6	-	-	504.8	-	-	505.0	505.0	505.0*	-	505.0	-	505.7	505.6	509.1	509.1	-	-	-	-	
OWC-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	521.7	521.7	521.6*	
OWC-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	515.6	515.5	515.6*	
OWC-18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	514.0	514.0	513.7*	
* The well was bailed within twenty-four hours prior to measurement.																								

* The well was bailed within twenty-four hours prior to measuring this water level and may not have fully recovered to static level.

Water levels measured by WCC personnel using Soil Test electronic water level indicator.

TABLE 4
GROUNDWATER PARAMETERS MEASURED DURING SAMPLING

Well	pH*		Specific Conductivity** μmhos/cm		Temperature °C	
	Feb. 1981	July 1981	Feb. 1981	July 1981	Feb. 1981	July 1981
OWC-1	6.3	6.3	960	1340	12.8	22
OWC-2	-	7.2	--	1100	--	21
OWC-3	6.4	6.4	1250	2300	14.0	25
OWC-4	6.3	5.9	1840	3200	12.1	23
OWC-5	6.5	6.3	1170	1100	13.0	24
OWC-6	6.2	6.1	860	1100	14.5	23
OWC-7	6.5	6.5	1480	2050	14.0	23
OWC-8	6.7	6.6	1090	1480	14.5	22
OWC-9	6.7	6.7	520	760	11.5	22
OWC-10	6.3	6.3	840	1110	12.4	22
OWC-11	7.0	6.4	1200	1910	12.0	22
OWC-12	7.2	7.1	700	950	16.3	22
OWC-13	6.6	6.0	1170	1890	13.0	25
OWC-14	6.8	6.8	860	1120	13.2	20
OWC-15	6.3	6.0	295	550	16.5	20
OWC-16	-	6.3	--	1800	--	22
OWC-17	-	6.3	--	2090	--	20
OWC-18	-	7.2	--	700	--	19

* Cole-Parmer Digi-sense LCD pH meter Model No. 5994-10.

** Yellow Springs Instrument salinity, conductivity and temperature meter Model No. 33.

TABLE 5

PARAMETERS PROPOSED FOR ANALYSIS OF SAMPLES

Organochlorine Pesticides:

DDE	Toxaphene
DDT	Lindane
Endrin	Kelthane
Dieldrin	DDD (TDE)
Aldrin	Captan
Mirex	Methoxychlor
Heptachlor	PCB's
Chlordane	Difolatan
Chlorobenzilate	

Organophosphorus Pesticides:

Phosdrin (Mevinphos)	Parathion
Diazinon	Trithion
Guthion	Malathion

Phenoxyacid Herbicides:

- 2,4-D
- 2,4,5-T

Heavy Metals:

- Arsenic
- Copper
- Zinc
- Cadmium

Total Organic Carbon

Standard Water Chemistry Analyses

Note: pH, salinity, conductivity and temperature are determined in the field when the water samples are obtained.

August 1? Zinc per? 4.0 2.1 mg/l

TABLE 6
GROUNDWATER QUALITY ANALYSES - ORTHO-CHEVRON, MARYLAND HEIGHTS, MISSOURI
JULY - AUGUST 1981

Inorganic Constituents	Concentrations, mg/l (ppm)																		Detection Limit
	OWC-1	OWC-2	OWC-3	OWC-4	OWC-5	OWC-6	OWC-7	OWC-8	OWC-9	OWC-10	OWC-11	OWC-12	OWC-13	OWC-14	OWC-15	OWC-16	OWC-17	OWC-18	
Arsenic	ND	.001	ND	ND	.002	.059	.80	.012	.004	.022	.018	.019	.002	ND	ND	.014	.024	.030	.001
Cadmium	.00057	.00069	.00082	.00095	.00059	.00028	.0021	.0012	.00059	.0034	.0014	.00069	.00047	.0013	.00033	.0048	.0021	.00050	.0001
Copper	.0005	.0005	.0004	.0005	.0009	.001	.019	.0007	.0005	.011	.0019	.0061	.0005	.0029	.0004	.0069	.0035	.0047	-
Zinc	.10	.16	.10	.05	.05	.15	.19	.09	.05	.13	.18	.19	.07	.06	.03	.09	.21	.17	-
pH	6.5	7.3	6.5	6.1	6.6	6.4	6.6	6.9	7.0	6.5	6.3	7.2	6.3	7.0	6.2	6.8	6.5	7.5	-
Total Dissolved Solids	765	646	1160	812	590	577	1225	932	500	677	907	556	846	695	225	1072	1285	474	-
Chloride	120	29	510	100	60	104	230	120	7	100	290	16	190	51	32	190	320	16	-
Fluoride	.24	1.0	.14	.12	.13	.21	.35	.15	.58	.25	.17	.28	.17	.19	.13	0.00	0.00	0.00	-
Nitrate (as NO ₃)	8.0	.9	11.1	14.6	0.00	3.6	.9	.9	1.1	.4	0.00	0.00	0.00	1.3	8.0	.4	0.00	0.00	-
Sulfate	150	97	113	85	107	133	190	85	20	95	123	85	205	80	55	55	80	33	-

EPA Drinking Water Standards *

Missouri Groundwater Recharge Standards*

Page 2 of 2

Groundwater samples to be analyzed for heavy metals were filtered through 0.45 micron pore size filter membranes and acid preserved at the time of collection. The groundwater samples analyzed for inorganics were analyzed in accordance with procedures published in the Federal Register, Volume 44, No. 233, December 23, 1979.

* The EPA Drinking Water Standards and Missouri Groundwater Recharge Standards are shown for comparison purposes only.

S81-5-2

Handwritten notes: 11.0 mg/l MONK, 22 2.2 .22, 175 0.5 1.75 mg/l, 10 mg/l, 1.0 mg/l, 5.0 mg/l

TABLE 6
GROUNDWATER QUALITY ANALYSES - ORTHO-CHEVRON, MARYLAND HEIGHTS, MISSOURI
JULY - AUGUST 1981

Page 1 of 2

		Concentration, ug/l (ppb)																		Detection Limit	EPA Drinking Water Standards	Missouri Groundwater Recharge Standards
Organic Constituents	OWC-1	OWC-2	OWC-3	OWC-4	OWC-5	OWC-6	OWC-7	OWC-8	OWC-9	OWC-10	OWC-11	OWC-12	OWC-13	OWC-14	OWC-15	OWC-16	OWC-17	OWC-18				
2,4-D - 509(B) St. M. H.	ND	ND	ND	ND	1.7	ND	7.4	ND	ND	ND	1600	67	3.7	ND	ND	3.8	57	1.1	1.0	100	--	
2,4,5-T - 509(B) "	.40	ND	ND	ND	.22	ND	3.9	.22	ND	ND	435	5.1	2.1	ND	ND	3.3	83	2.4	.1	10	--	
4,4-DDD - 608	ND	ND	ND	ND	ND	.99	12.3	ND	.91	ND	2.6	ND	1.4	ND	ND	ND	1.66	.77	.2	--	--	
4,4-DDE - 608	ND	ND	ND	ND	ND	ND	ND	ND	.19	ND	ND	ND	ND	ND	ND	ND	1.22	ND	.2	--	--	
4,4-DDT - 608	ND	ND	ND	ND	ND	ND	8.8	ND	.84	ND	.81	.65	ND	ND	ND	ND	.62	.45	.3	--	--	
Aldrin - 608	ND	ND	ND	ND	ND	ND	26	ND	ND	ND	ND	2.3	ND	ND	ND	ND	ND	.77	.2	--	--	
Diazinon - 509(C) St. M.	ND	ND	ND	ND	ND	5.8	ND	.78	ND	8.7	1.6	ND	ND	ND	ND	.63	ND	.84	.5	--	--	
Dieldrin - 608	ND	ND	ND	ND	ND	1.46	6.25	ND	.41	1.01	22	1.51	ND	ND	ND	.27	1.55	1.20	.2	--	--	
Endrin - (608)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	.4	.2	--	
Ethyl-Parathion - 509(C)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	48	ND	ND	ND	ND	ND	ND	.5	--	--	
Heptachlor - 608	ND	ND	ND	ND	ND	ND	ND	ND	ND	.52	ND	.25	2.43	ND	ND	2.0	ND	ND	.2	--	--	
Lindane - 608	.15	.23	.30	ND	.26	5.78	410	32.6	.45	10	64	32	234	3.56	.38	.91	62	58	.1	4.0	--	
Malathion - 509(C)	ND	ND	ND	ND	ND	4.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0	--	--	
Methyl-Parathion - 509(C)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0	--	--	
Mirex - (608)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	.5	--	--	
PCB - 608	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10	--	--	
Phosdrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	.88	3.1	ND	ND	ND	ND	ND	1.0	--	--	

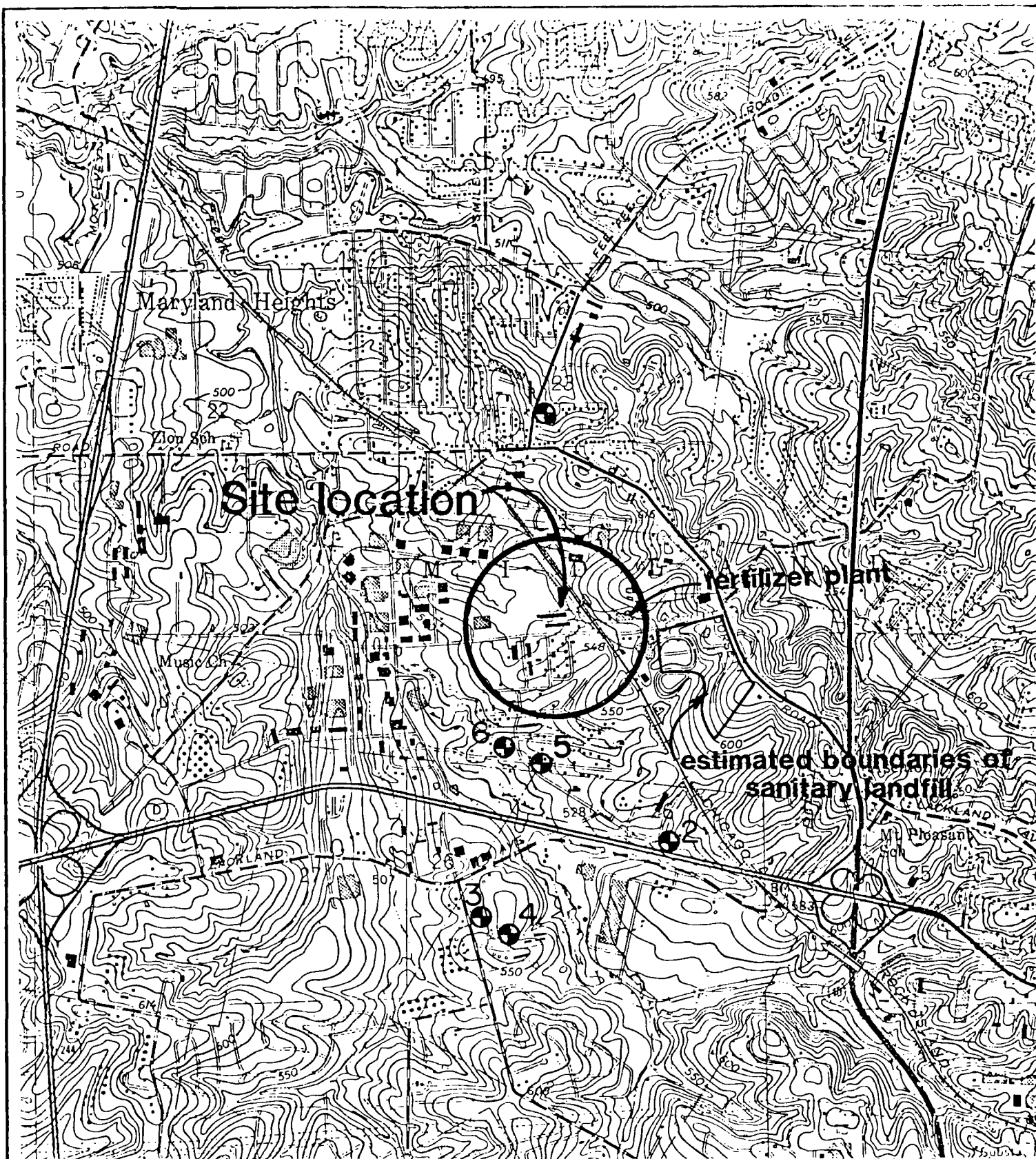
The following organic pesticide compounds were analyzed for and were not detected in any of the groundwater samples during either sampling period:

Constituent	Detection Limit, ug/l (ppb)
Captan	.20
Chlordane	1.0
Chlorobenzilate	.30
Difolatan	20.0
Guthion	100.0
Methoxychlor	.8
Toxaphene	10.0
Kelthane	10.0

*The EPA Drinking Water standards and Missouri Groundwater Recharge Standards are shown for comparison purposes only.

S81-5-2

509(C) - Total ACHE Inhibition - Organophosphates + Carbamate Pesticides
509(B) - Hydrolysis followed by GC/EC detector - Chlorinated Phenoxy Herbicides



Compiled from USGS Creve Coeur, Missouri quadrangle map, 1954, Revised 1968.

- — Approximate locations of public and private water supply wells in the immediate vicinity of the plant.



0 1000 2000
SCALE, ft

HYDROGEOLOGY STUDY & GROUNDWATER CHARACTERISTICS
MARYLAND HEIGHTS, MISSOURI
ORTHO-CHEVRON CHEMICAL COMPANY

PROJECT NO.
S 81-5-2

WOODWARD-CLYDE CONSULTANTS

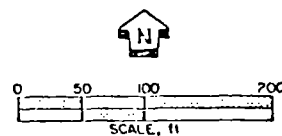
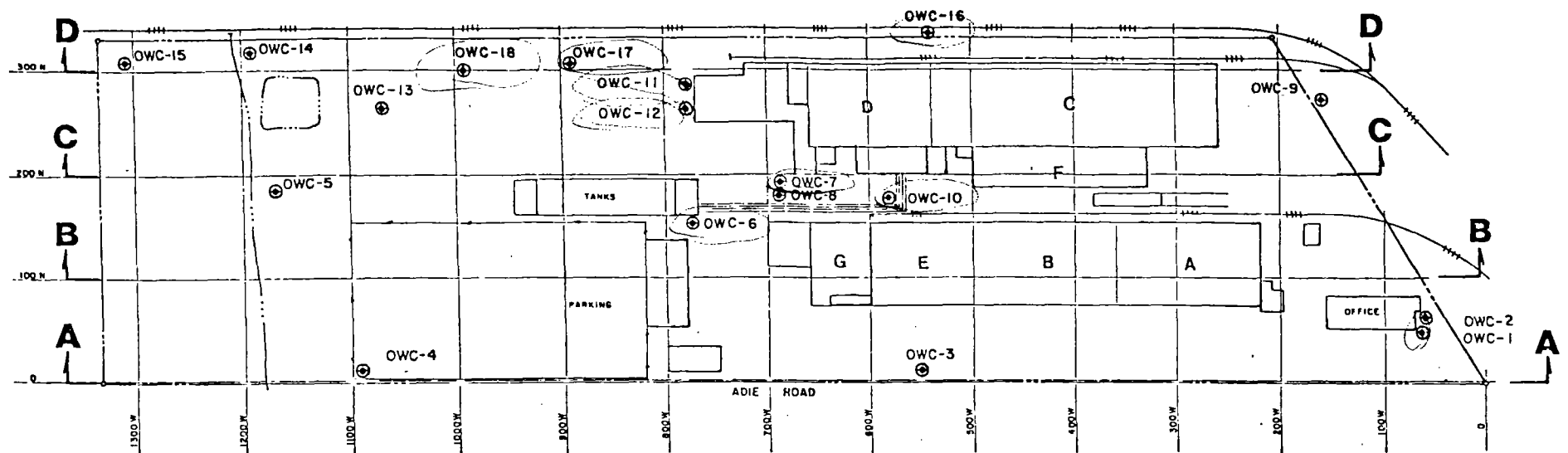
CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS
CENTRAL REGION

DRN. BY: *PK* 3-29-81
CHKD BY: *PK*

SITE LOCATION MAP

FIG. NO.
1

Reproduced from the site plan provided by
the Ortho-Chevron Chemical Company.



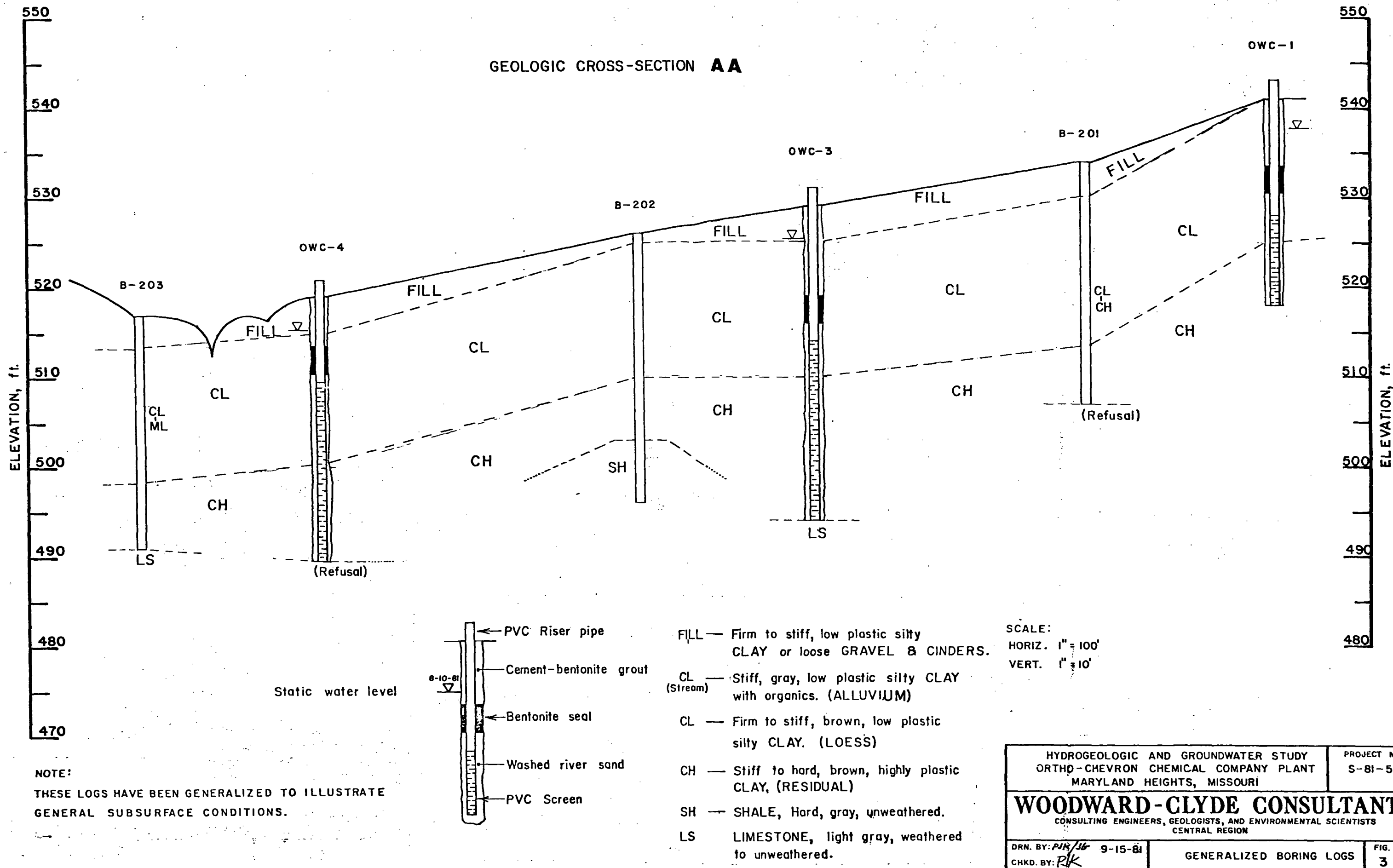
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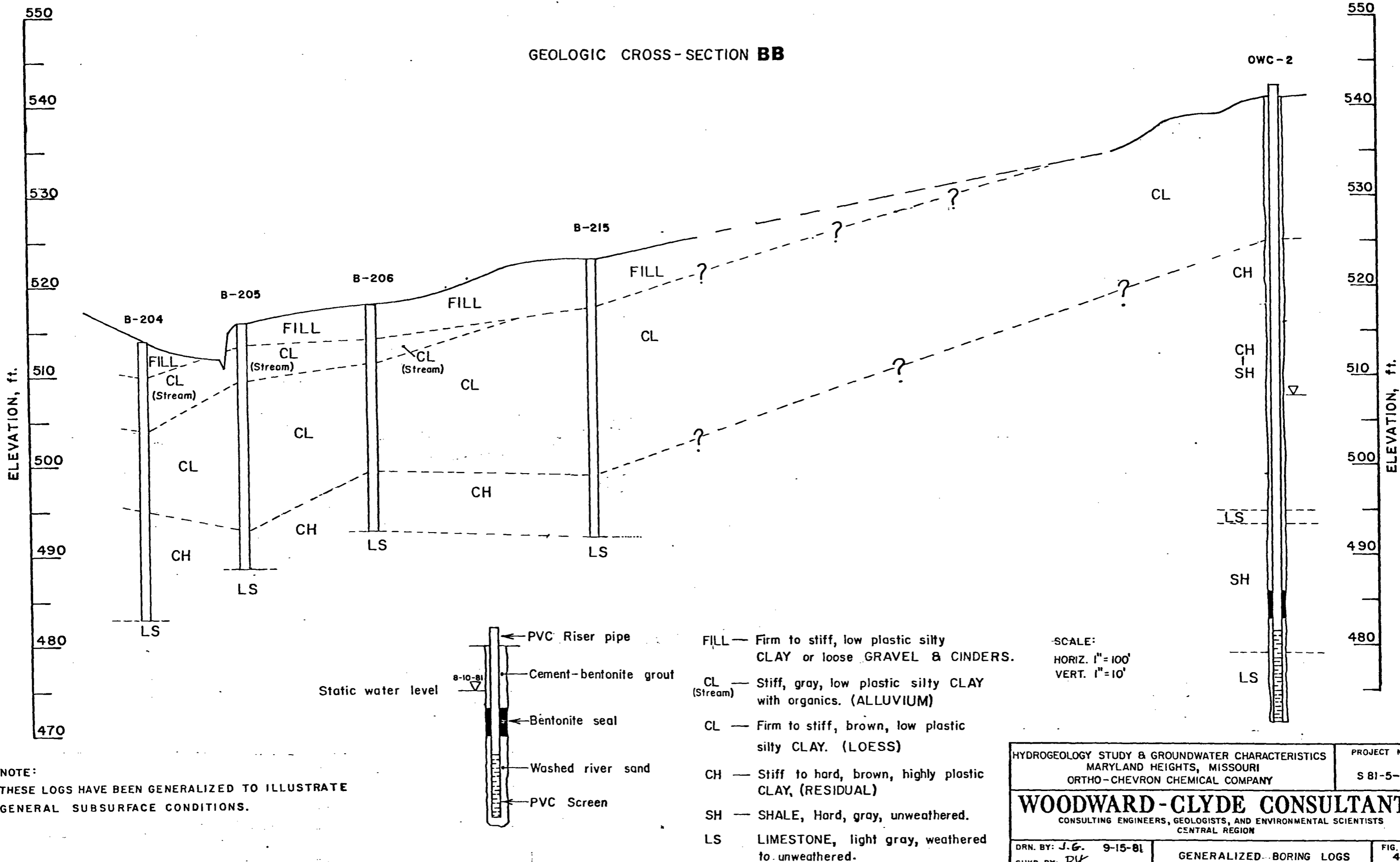
— Geologic cross-sections; refer to figures 3 through 6

OWC-1

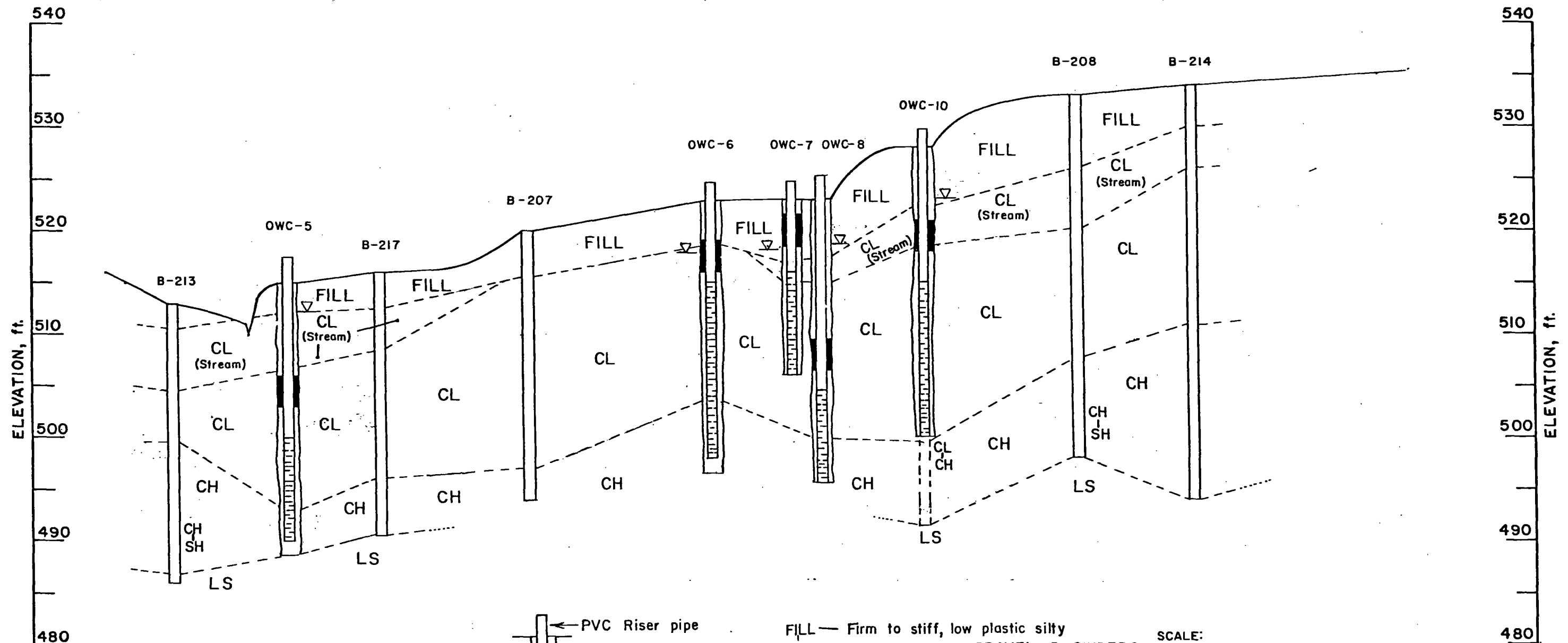
— Groundwater well location and designation

HYDROGEOLOGY STUDY & GROUNDWATER CHARACTERISTICS MARYLAND HEIGHTS, MISSOURI ORTHO-CHEVRON CHEMICAL COMPANY		PROJECT NO. S 81-5-2
WOODWARD-CLYDE CONSULTANTS CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS CENTRAL REGION		
DRAWN BY: R.M.	9-16-81	FIG. NO.
CHECKED BY: BJK	SITE PLAN	2





GEOLOGIC CROSS-SECTION CC



NOTE:
THESE LOGS HAVE BEEN GENERALIZED TO ILLUSTRATE
GENERAL SUBSURFACE CONDITIONS.

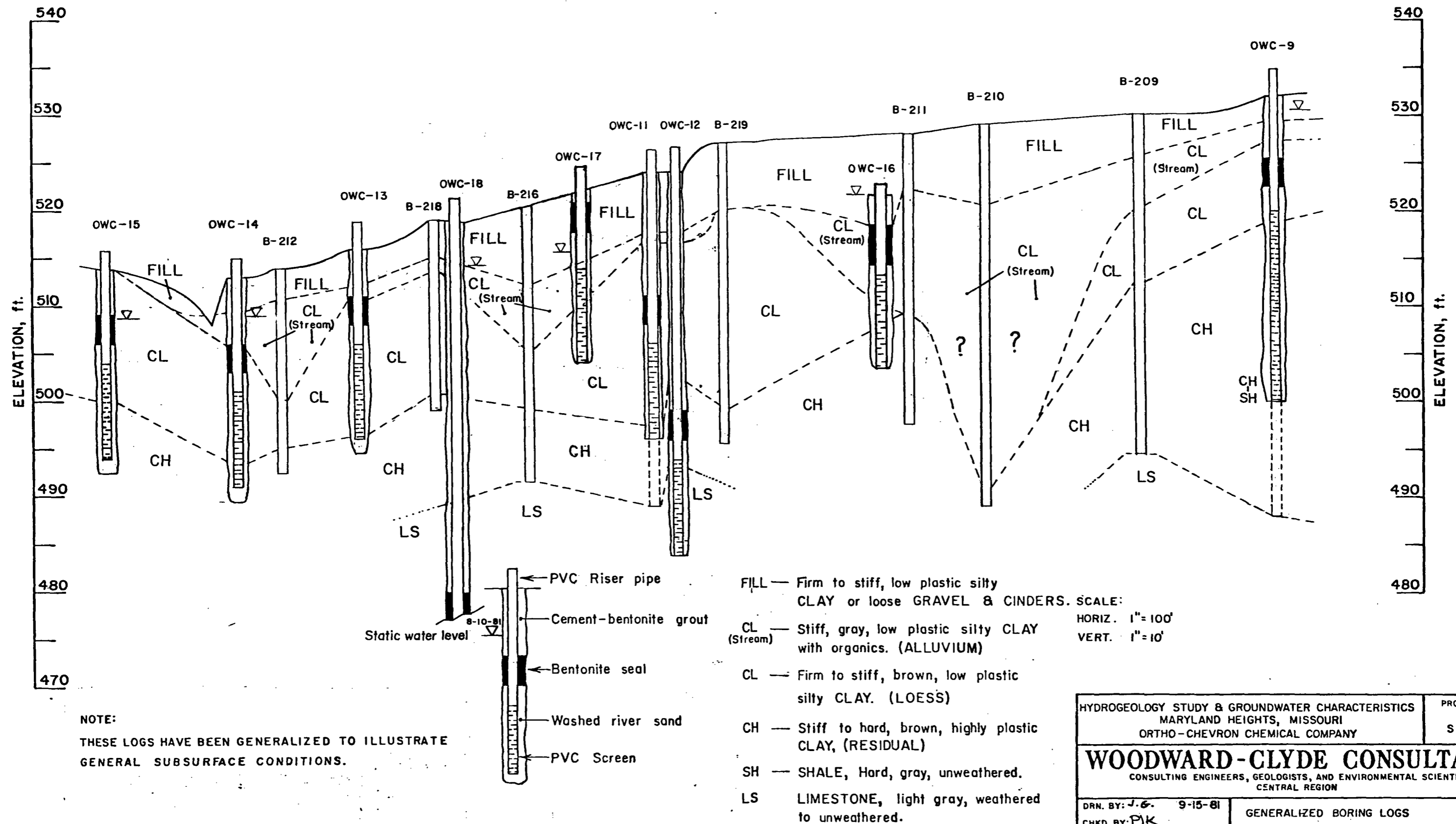
- FILL — Firm to stiff, low plastic silty
CLAY or loose GRAVEL & CINDERS.
- CL (Stream) — Stiff, gray, low plastic silty CLAY
with organics. (ALLUVIUM)
- CL — Firm to stiff, brown, low plastic
silty CLAY. (LOESS)
- CH — Stiff to hard, brown, highly plastic
CLAY, (RESIDUAL)
- SH — SHALE, Hard, gray, unweathered.
- LS — LIMESTONE, light gray, weathered
to unweathered.

SCALE:
HORIZ. 1" = 100'
VERT. 1" = 10'

HYDROGEOLOGY STUDY & GROUNDWATER CHARACTERISTICS MARYLAND HEIGHTS, MISSOURI ORTHO-CHEVRON CHEMICAL COMPANY		PROJECT NO. S 81-5-2
WOODWARD-CLYDE CONSULTANTS CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS CENTRAL REGION		
DRN. BY: JG. CHKD. BY: BK.	9-15-81	FIG. NO. 5

GENERALIZED BORING LOGS

GEOLOGIC CROSS-SECTION DD



HYDROGEOLOGY STUDY & GROUNDWATER CHARACTERISTICS
MARYLAND HEIGHTS, MISSOURI
ORTHO-CHEVRON CHEMICAL COMPANY

PROJECT NO.
S 81-5-2

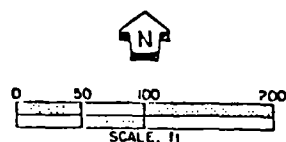
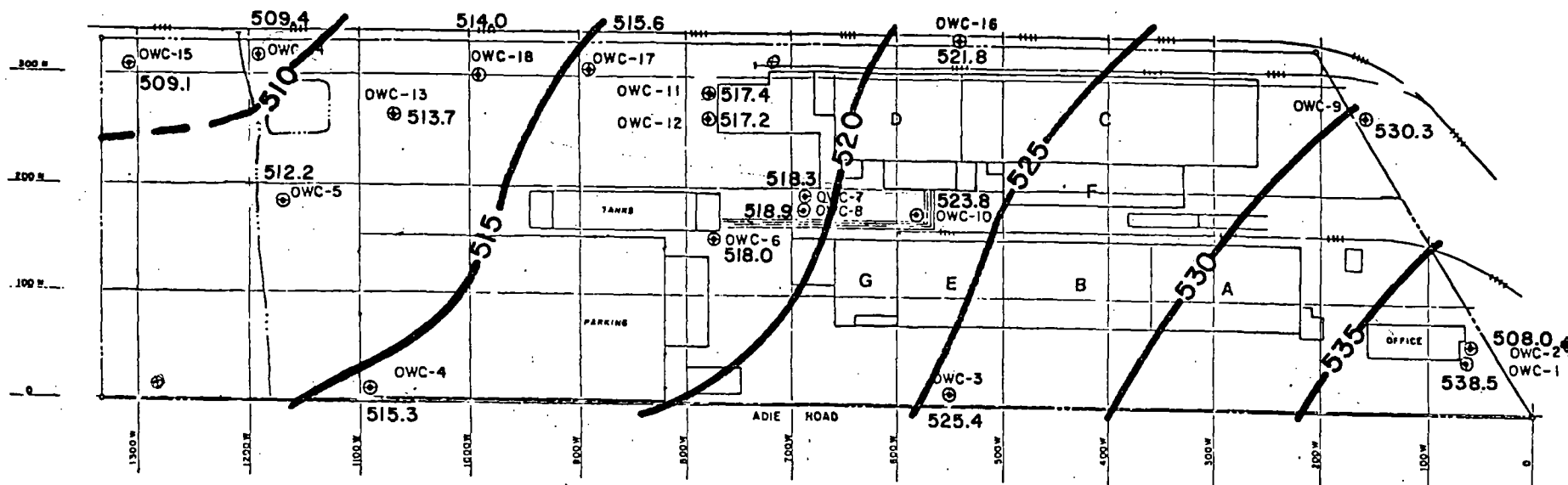
WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS
CENTRAL REGION

DRN. BY: J.G. 9-15-81
CHKD. BY: PJK

GENERALIZED BORING LOGS

FIG. NO.
6

Reproduced from the site plan provided by
the Ortho-Chevron Chemical Company.



— 535 —

Groundwater contours interpreted
from July and August groundwater levels

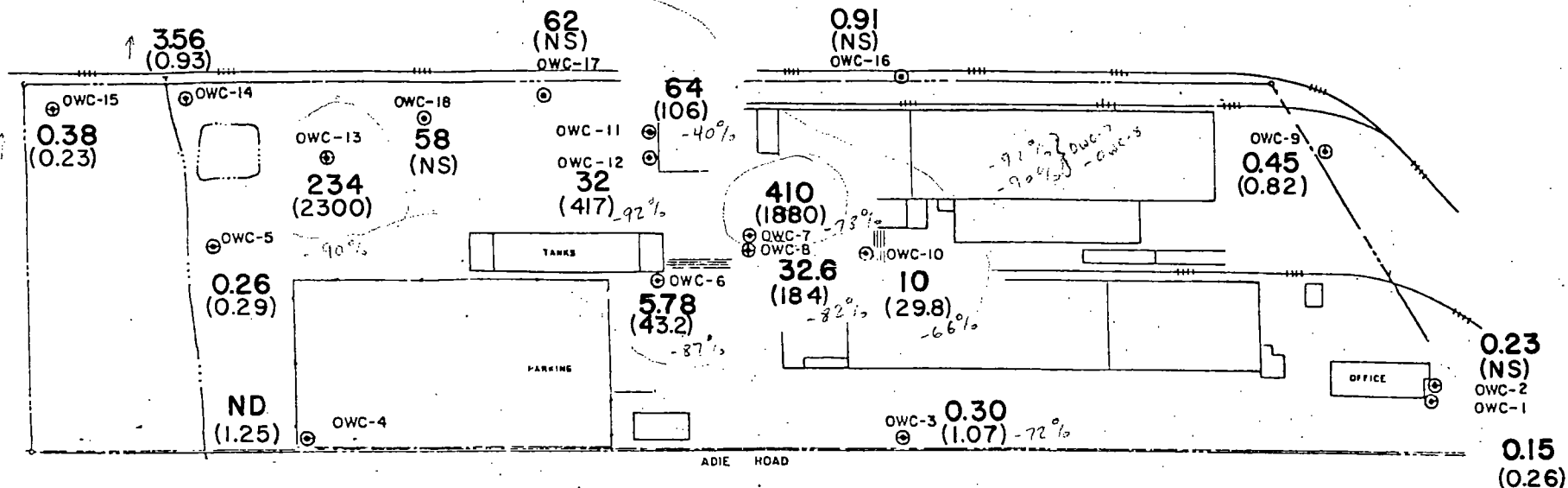
538.5 — Elevation of groundwater observed during July and August, 1981
OWC-1 — Groundwater well location and designation

OWC-2 — Poorly recharging well
into limestone

HYDROGEOLOGY STUDY & GROUNDWATER CHARACTERISTICS MARYLAND HEIGHTS, MISSOURI ORTHO-CHEVRON CHEMICAL COMPANY		PROJECT NO. S 81-5-2
WOODWARD-CLYDE CONSULTANTS CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS CENTRAL REGION		
DRAWN BY: K.M.	9-16-81	GROUNDWATER CONTOUR MAP
CHECKED BY: BJK		
		FIG. NO. 7

2.04 NS/D
92 NS/D
310 NS/D
31
3.1
180 WS
4 Aug 81
meL 4.0 NS/D

Reproduced from the site plan provided by the Ortho-Chevron Chemical Company.



0.05 — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Aug. '81.

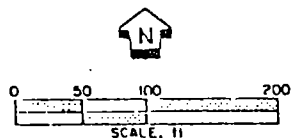
LINDANE, $\mu\text{g/l}$

(0.05) — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Feb. '81.

NS — Indicates not sampled

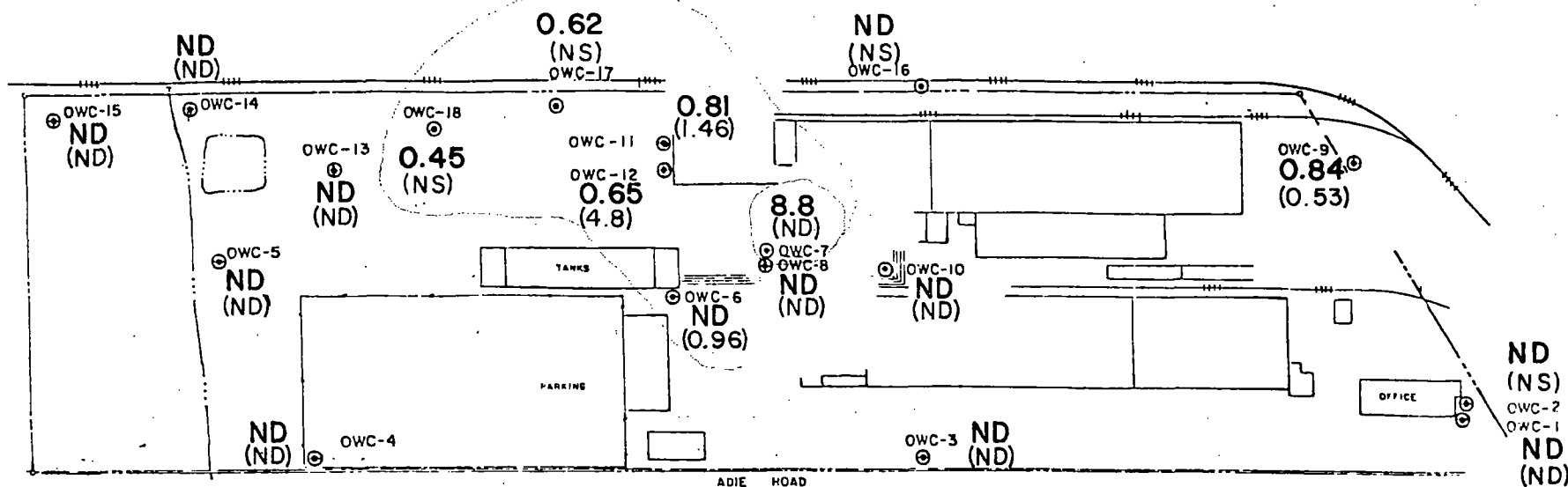
ND — Indicates none detected, detection limit = 0.10

OWC-1 — Groundwater well location and designation



HYDROGEOLOGY STUDY & GROUNDWATER CHARACTERISTICS MARYLAND HEIGHTS, MISSOURI ORTHO-CHEVRON CHEMICAL COMPANY		PROJECT NO S 81-5-2
WOODWARD-CLYDE CONSULTANTS CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS CENTRAL REGION		
DRAWN BY: <i>A.M.</i> CHECKED BY: <i>DJK</i>	Contaminant Distribution	FIG. NO 8

Reproduced from the site plan provided by the Ortho-Chevron Chemical Company.



4,4-DDT, $\mu\text{g/l}$

0.05 — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Aug. '81.

(0.05) — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Feb. '81.

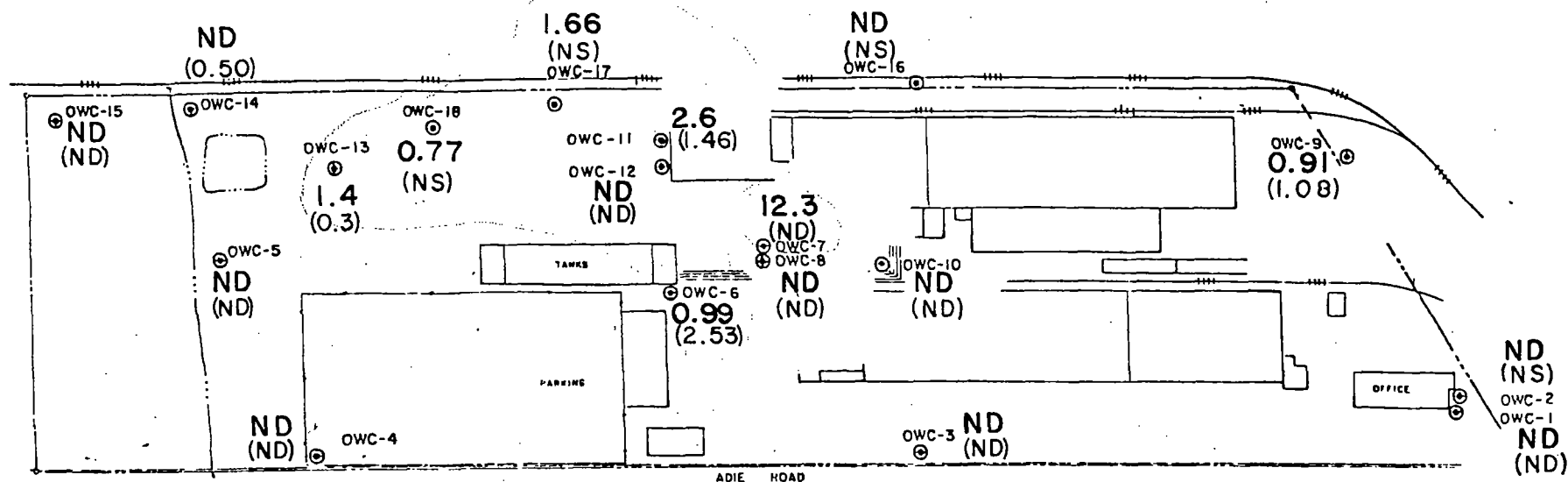
NS — Indicates not sampled

ND — Indicates none detected, detection limit = 0.30

OWC-1 — Groundwater well location and designation

HYDROGEOLOGY STUDY & GROUNDWATER CHARACTERISTICS MARYLAND HEIGHTS, MISSOURI ORTHO-CHEVRON CHEMICAL COMPANY		PROJECT NO. RI-4-2
WOODWARD-CLYDE CONSULTANTS CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS CENTRAL REGION		
DATE BY: J.M. CHECKED BY: D.K.	9-21-81	Contaminant Distribution

Reproduced from the site plan provided by the Ortho-Chevron Chemical Company.



4,4-DDD, $\mu\text{g}/\text{l}$

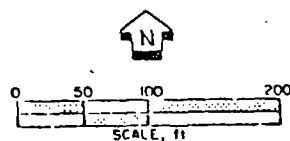
0.05 — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Aug. '81.

(0.05) — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Feb. '81.

NS — Indicates not sampled

ND — Indicates none detected, detection limit = 0.2

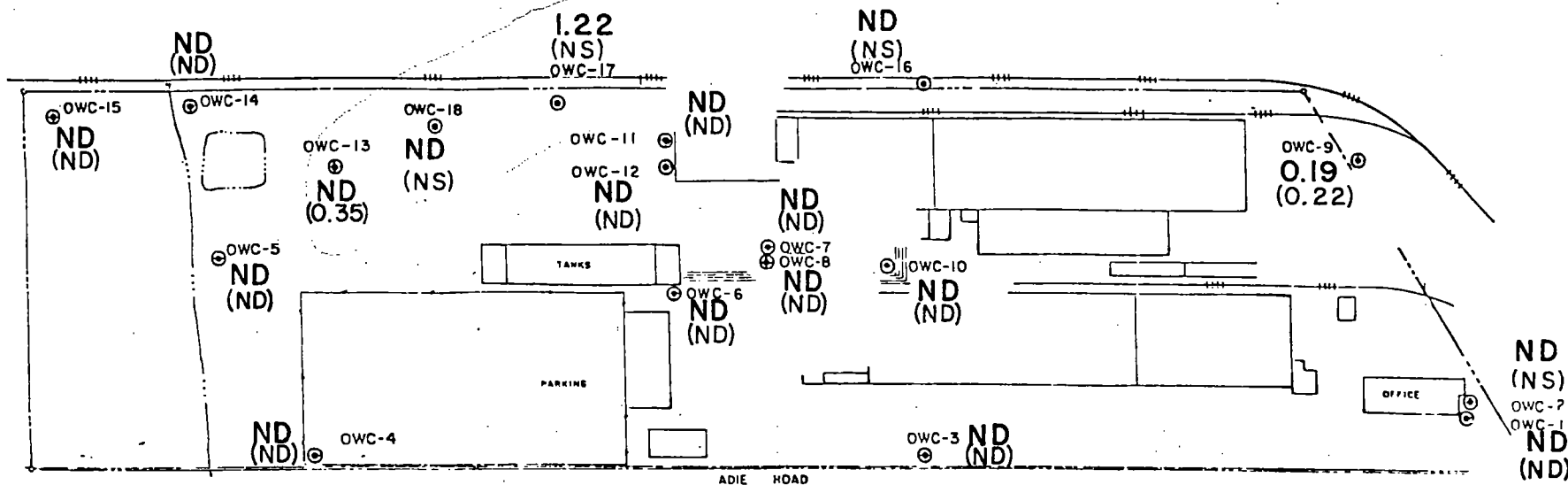
OWC-1 — Groundwater well location and designation



HYDROGEOLOGY STUDY & GROUNDWATER CHARACTERISTICS MARYLAND HEIGHTS, MISSOURI ORTHO-CHEVRON CHEMICAL COMPANY		PROJECT NO. SRI-5-2
WOODWARD-CLYDE CONSULTANTS CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS CENTRAL REGION		
DATE: 9-21-81 DRAWN BY: BJK	Contaminant Distribution	FIG. NO. 10

Handwritten notes: *10504310*

Reproduced from the site plan provided by the Ortho-Chevron Chemical Company.



4,4-DDE, $\mu\text{g/l}$

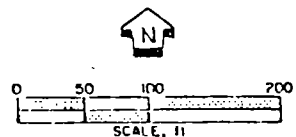
0.05 — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Aug. '81.

(0.05)— Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Feb. '81.

NS — Indicates not sampled

ND — Indicates none detected, detection limit = 0.20

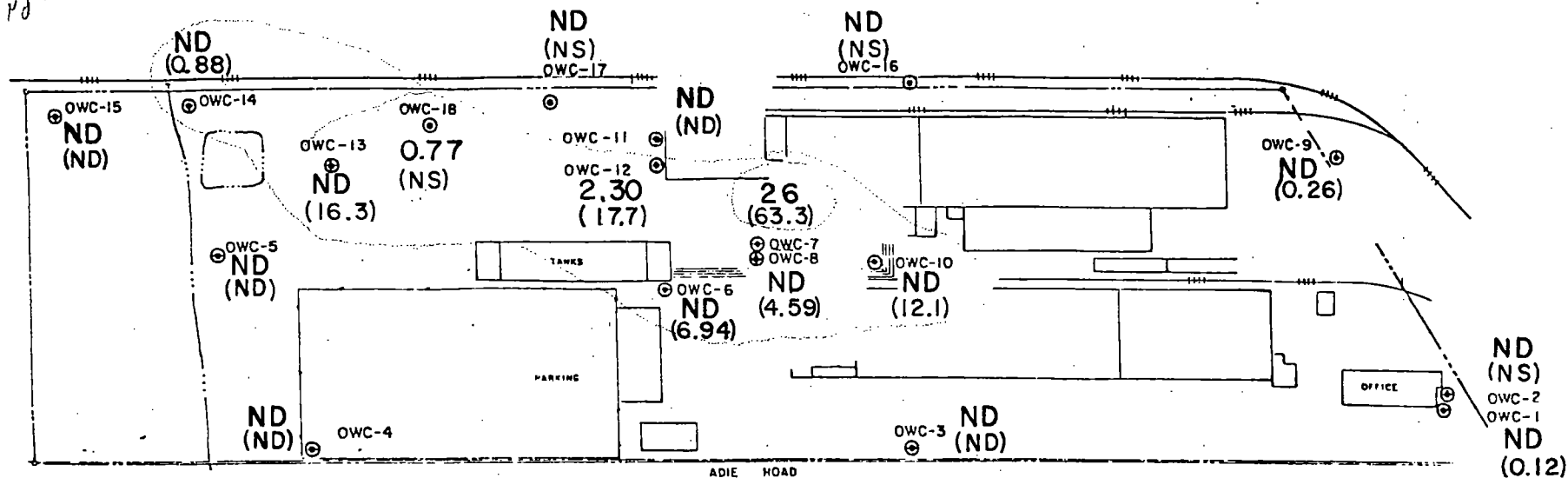
OWC-1 — Groundwater well location and designation



HYDROGEOLOGY STUDY & GROUNDWATER CHARACTERISTICS MARYLAND HEIGHTS, MISSOURI ORTHO-CHEVRON CHEMICAL COMPANY		PROJECT NO. 5-H-5-2
WOODWARD-CLYDE CONSULTANTS CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS CENTRAL REGION		
DRAWN BY: <i>KM</i>	9-21-81	Contaminant Distribution
CHECKED BY: <i>BJK</i>		11

AWD
07
3.0 12/11
14 NS 10
0.74
0.074

Reproduced from the site plan provided by the Ortho-Chevron Chemical Company.



ALDRIN, $\mu\text{g}/\text{l}$

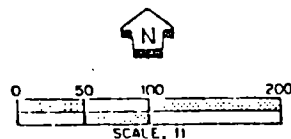
0.05 — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Aug. '81.

(0.05) — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Feb. '81.

NS — Indicates not sampled

ND — Indicates none detected, detection limit = .20

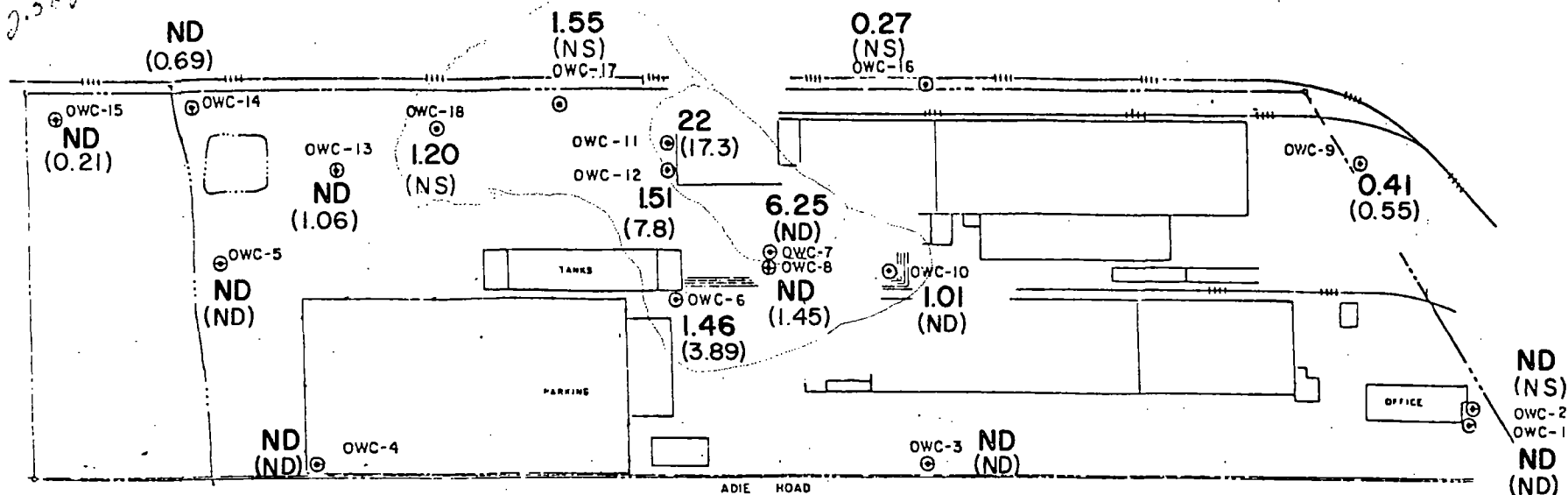
OWC-1 — Groundwater well location and designation



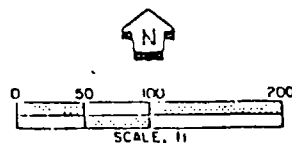
HYDROGEOLOGY STUDY & GROUNDWATER CHARACTERISTICS MARYLAND HEIGHTS, MISSOURI ORTHO-CHEVRON CHEMICAL COMPANY		PROJECT NO. SRI-5-2
WOODWARD-CLYDE CONSULTANTS CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS CENTRAL DIVISION		
DATE: 9-21-81 CHECKED BY: BJK	Contaminant Distribution	FILE NO. 12

AUCDE
 Ag
 .0019 NSID
 2.5 NSID
 .071 NSID
 .0071

Reproduced from the site plan provided by the Ortho-Chevron Chemical Company.



DIELDRIN, µg / l



0.05 — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Aug.'81.

(0.05) — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Feb.'81.

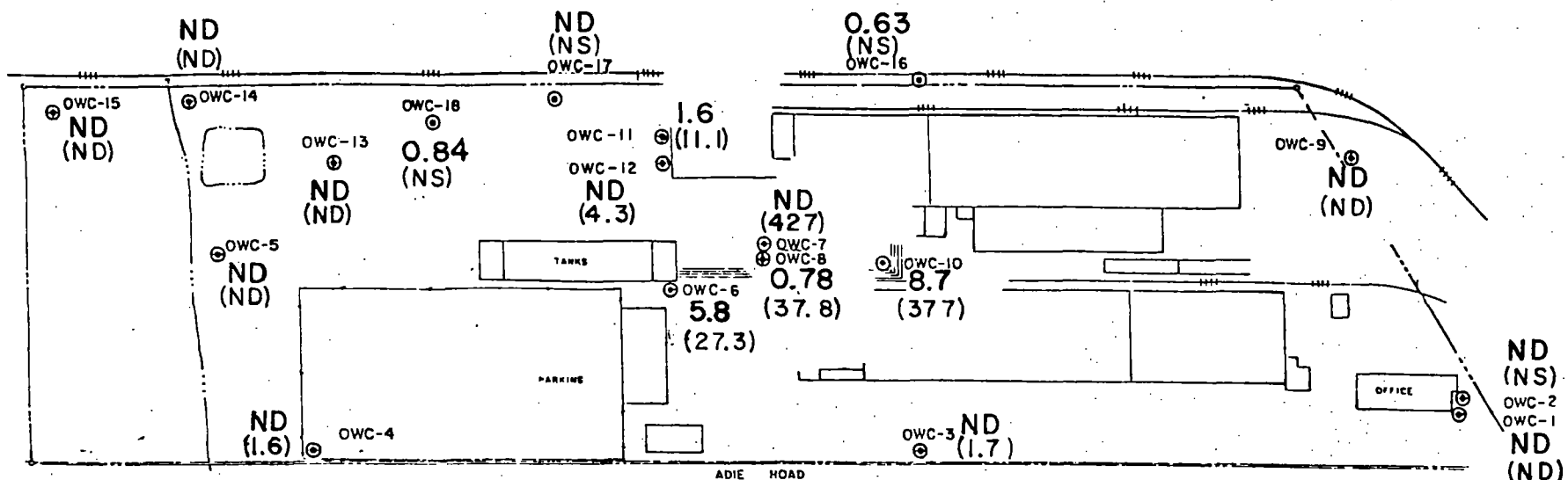
NS — Indicates not sampled

ND — Indicates none detected, detection limit =

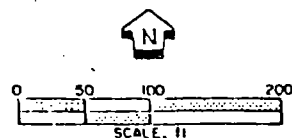
OWC-1 — Groundwater well location and designation

HYDROGEOLOGY STUDY & GROUNDWATER CHARACTERISTICS MARYLAND HEIGHTS, MISSOURI ORTHO-CHEVRON CHEMICAL COMPANY		PROJECT NO. S RI-5-2
WOODWARD-CLYDE CONSULTANTS CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS CENTRAL REGION		
DRAWN BY: KJM CHECKED BY: BJK	9-21-81 Contaminant Distribution	FILE NO. 13

Reproduced from the site plan provided by
the Ortho-Chevron Chemical Company.



DIAZINON, µg/l



0.05 — Indicates groundwater constituent concentrations as
measured in groundwater samples obtained in Aug. '81.

(0.05) — Indicates groundwater constituent concentrations as
measured in groundwater samples obtained in Feb. '81.

NS — Indicates not sampled

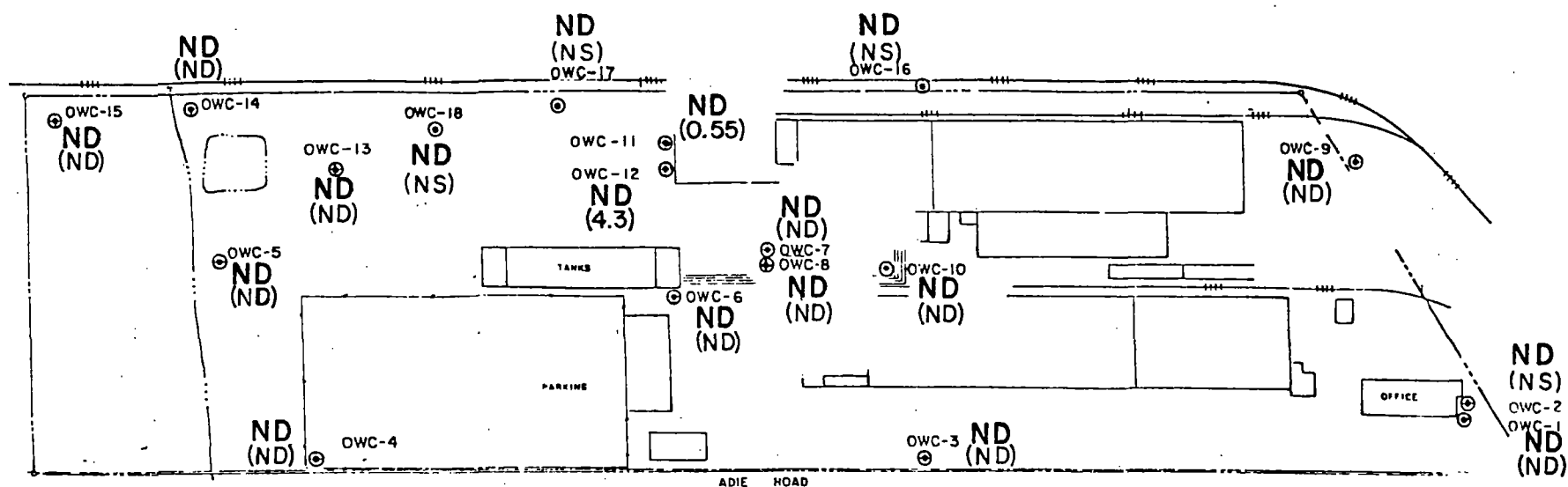
ND — Indicates none detected, detection limit = 0.5

OWC-1 — Groundwater well location and designation

HYDROGEOLOGY STUDY & GROUNDWATER CHARACTERISTICS MARYLAND HEIGHTS, MISSOURI ORTHO-CHEVRON CHEMICAL COMPANY		PROJECT NO. S RI-5-2
WOODWARD-CLYDE CONSULTANTS CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS CENTRAL REGION		
DRAWN BY: KJM CHECKED BY: BJK	9-21-81 Contaminant Distribution	FILE NO. 14

mel 0.0 NS/0

Reproduced from the site plan provided by the Ortho-Chevron Chemical Company.



ENDRIN, µg/l

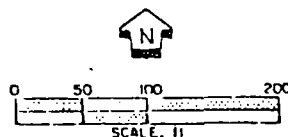
0.05 — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Aug. '81.

(0.05) — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Feb. '81.

NS — Indicates not sampled

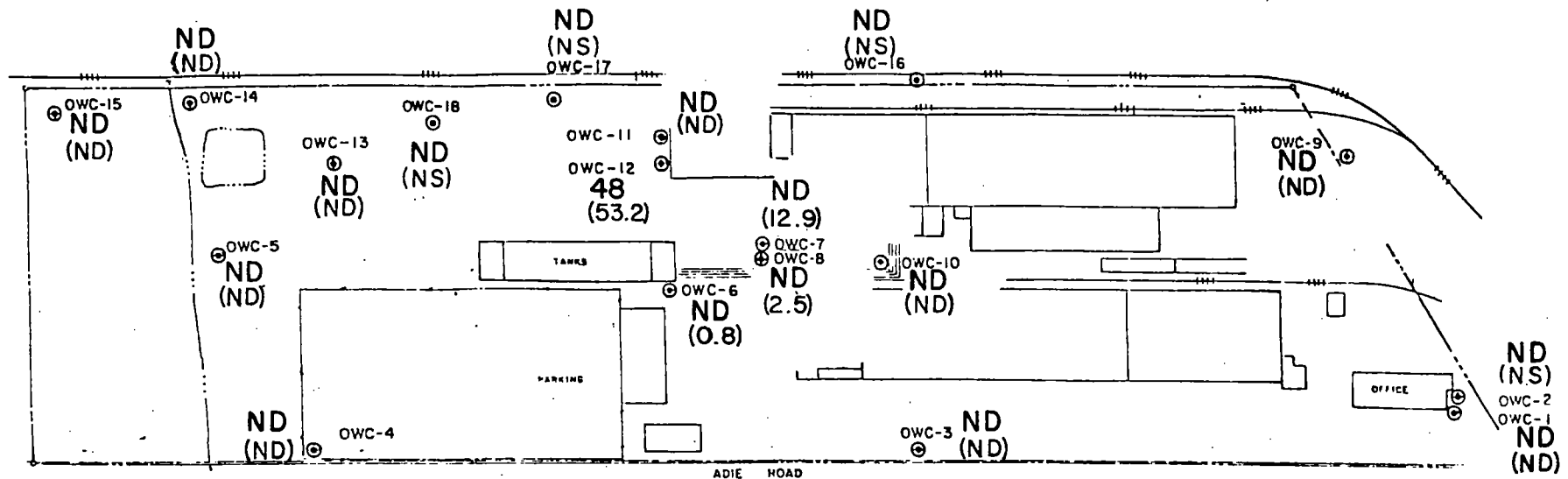
ND — Indicates none detected, detection limit = 0.40

OWC-1 — Groundwater well location and designation



HYDROGEOLOGY STUDY & GROUNDWATER CHARACTERIZATION MARYLAND HEIGHTS, MISSOURI ORTHO-CHEVRON CHEMICAL COMPANY		PROJECT NO. SRI-5-2
WOODWARD-CLYDE CONSULTANTS CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS CENTRAL REGION		
DATE: 9-21-81 DRAWN BY: DJK	Contaminant Distribution	FILE NO. 15

Reproduced from the site plan provided by the Ortho-Chevron Chemical Company.



ETHYL-PARATHION, $\mu\text{g/l}$

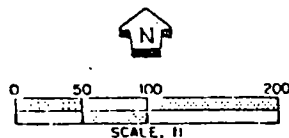
0.05 — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Aug. '81.

(0.05) — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Feb. '81.

NS — Indicates not sampled

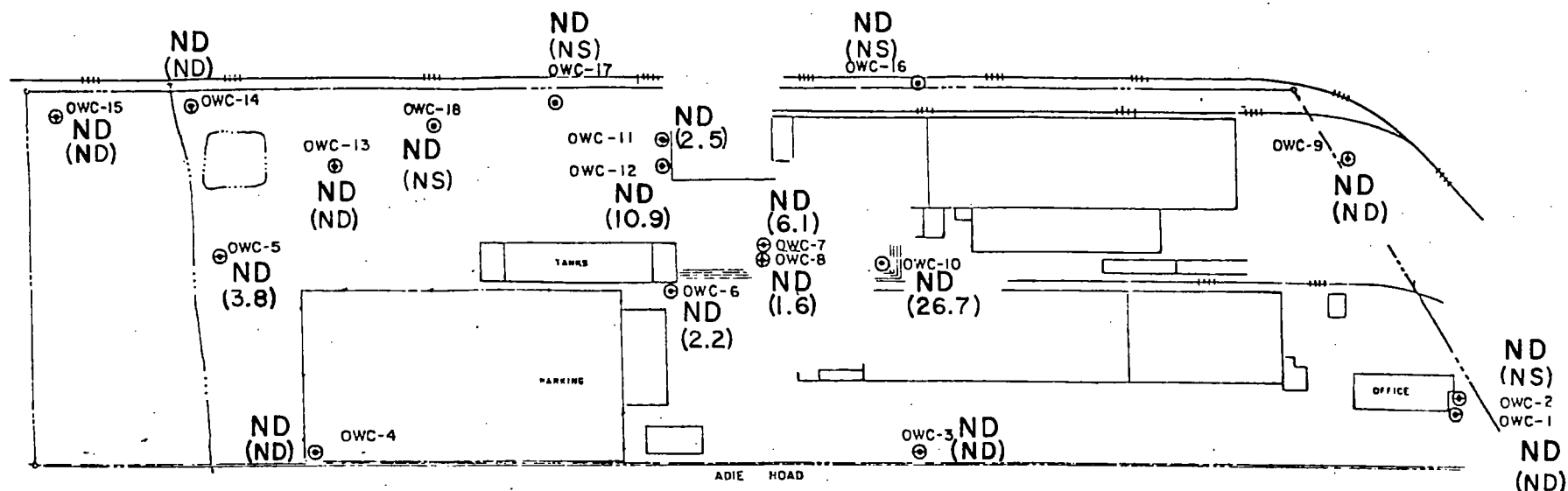
ND — Indicates none detected, detection limit = 0.5

OWC-1 — Groundwater well location and designation



HYDROGEOLOGY STUDY & GROUNDWATER CHARACTERISTICS MARYLAND HEIGHTS, MISSOURI ORTHO-CHEVRON CHEMICAL COMPANY		PROJECT NO. CRI-5-2
WOODWARD-CLYDE CONSULTANTS CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS CENTRAL REGION		
DATE: 9-21-81 DRAWN BY: PJK	CONTAMINANT DISTRIBUTION	
		16

Reproduced from the site plan provided by the Ortho-Chevron Chemical Company.



METHYL-PARATHION, µg/l

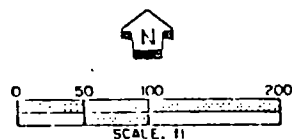
0.05 - Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Aug.'81.

(0.05) - Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Feb.'81.

NS - Indicates not sampled

ND - Indicates none detected, detection limit = 1.0 (2.0)

OWC-1 - Groundwater well location and designation



HYDROGEOLOGY STUDY B GROUNDWATER CHARACTERISTICS
MARYLAND HEIGHTS, MISSOURI
ORTHO-CHEVRON CHEMICAL COMPANY

PROJECT NO.
5 RI-5-2

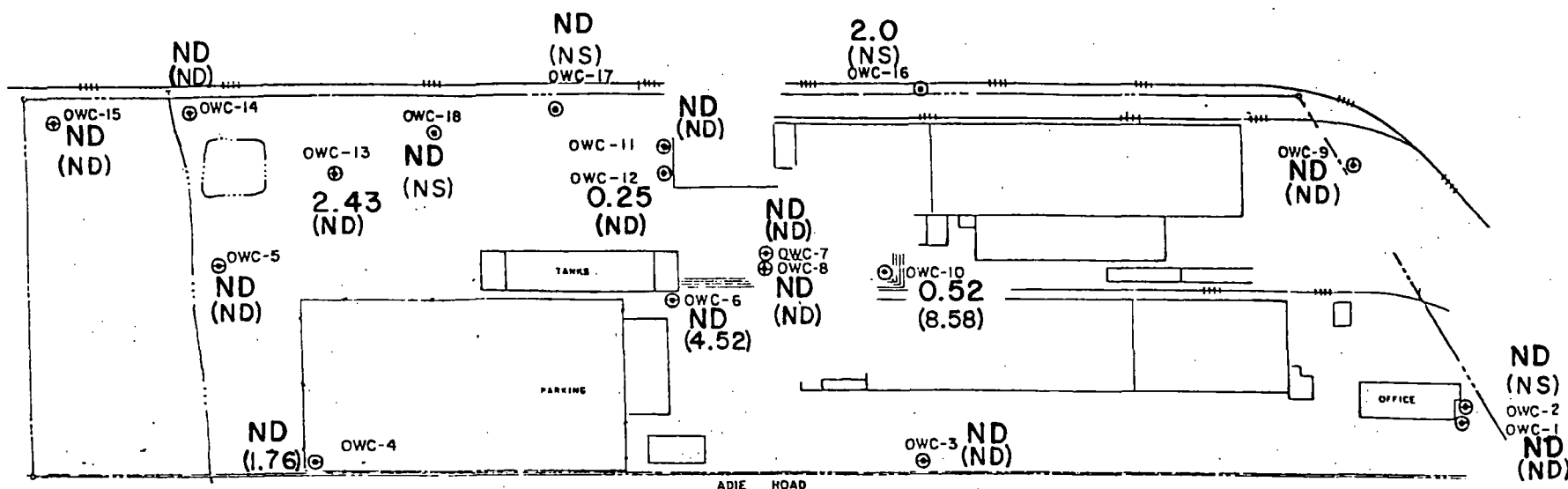
WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, BIOLOGISTS, AND ENVIRONMENTAL SCIENTISTS
CENTRAL REGION

DRAWN BY: *AK* 9-21-81
CHECKED BY: *DJK*

Contaminant Distribution

PAGE
17

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0.05 — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Aug. '81.

(0.05) — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Feb. '81.

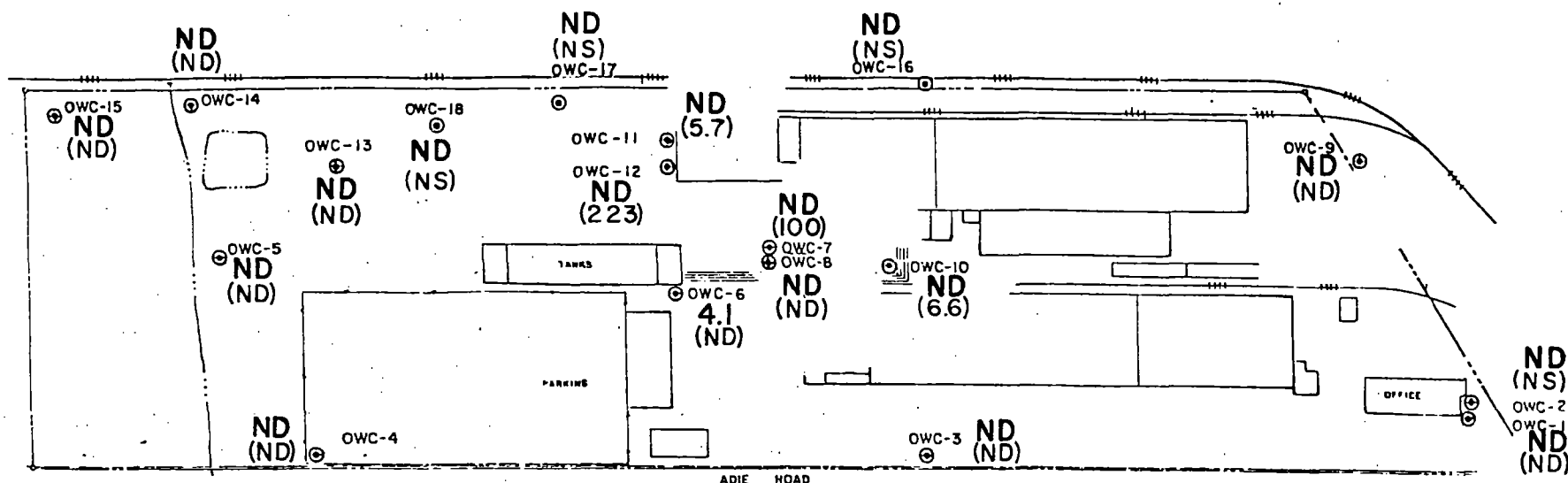
NS — Indicates not sampled

ND — Indicates none detected, detection limit = 0.20 (0.10)

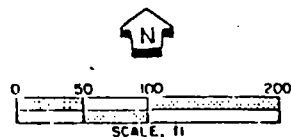
OWC-1 — Groundwater well location and designation

HYDROGEOLOGY STUDY & GROUNDWATER CHARACTERISTICS MARYLAND HEIGHTS, MISSOURI ORTHO-CHEVRON CHEMICAL COMPANY		PROJECT NO. RI-5-2
WOODWARD-CLYDE CONSULTANTS CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS CENTRAL REGION		
DATE BY: 9-21-81	FIG. 18	
CHECK BY: DJK	Contaminant Distribution	

Reproduced from the site plan provided by the Ortho-Chevron Chemical Company.



MALATHION, µg/l



0.05 - Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Aug. '81.

(0.05) - Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Feb. '81.

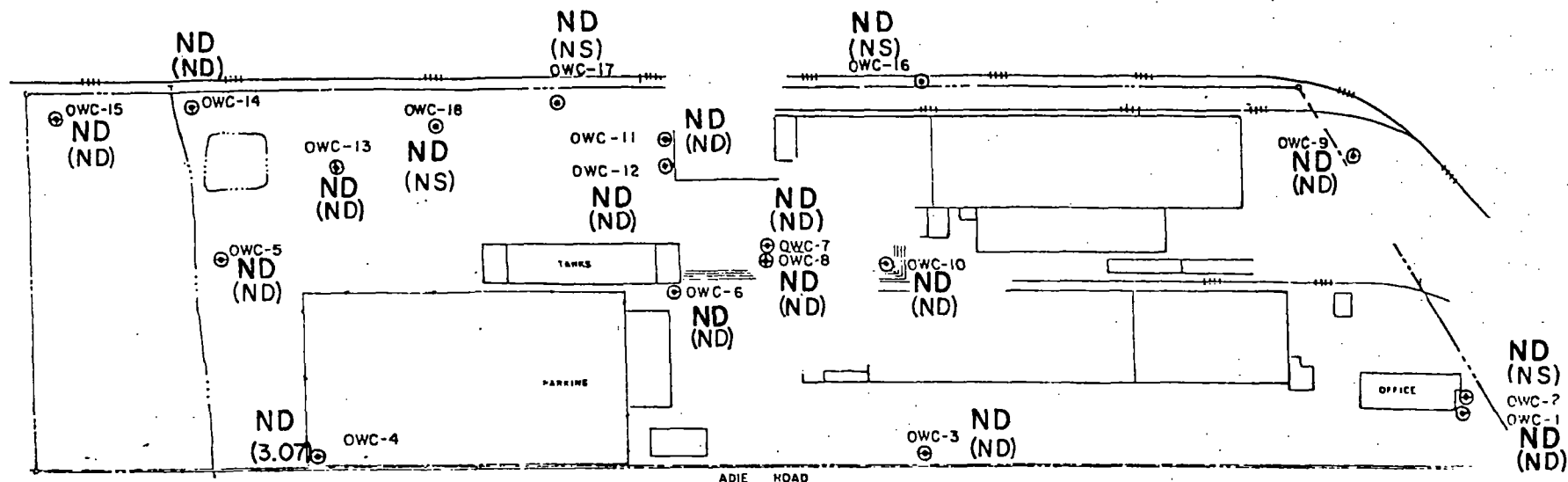
NS - Indicates not sampled

ND - Indicates none detected, detection limit = 1.0 (2.0)

OWC-1 - Groundwater well location and designation

HYDROGEOLOGY STUDY B GROUNDWATER CHARACTERISTICS MARYLAND HEIGHTS, MISSOURI ORTHO-CHEVRON CHEMICAL COMPANY		PROJECT NO. 9-21-81-2
WOODWARD-CLYDE CONSULTANTS CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS CENTRAL REGION		
DRN BY: <i>AK</i> 9-21-81 CHKD BY: <i>BJK</i>	Contaminant Distribution	FIG. 19

Reproduced from the site plan provided by the Ortho-Chevron Chemical Company.



MIREX, µg/l

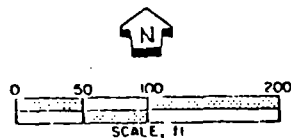
0.05 — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Aug. '81.

(0.05) — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Feb. '81.

NS — Indicates not sampled

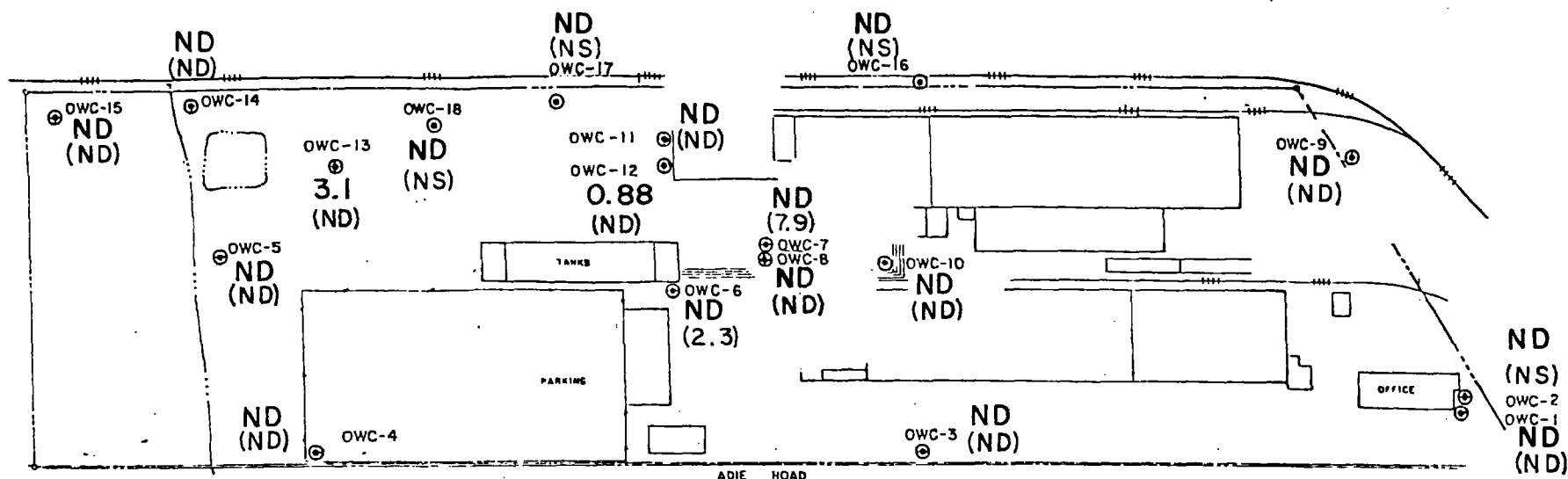
ND — Indicates none detected, detection limit = 0.5

OWC-1 — Groundwater well location and designation



HYDROGEOLOGY STUDY & GROUNDWATER CHARACTERISTICS		PROJECT NO.
MARYLAND HEIGHTS, MISSOURI		RI-5-2
ORTHO-CHEVRON CHEMICAL COMPANY		
WOODWARD-CLYDE CONSULTANTS		
CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS		
CENTRAL REGION		
DATE: 9-21-81	Contaminant Distribution	PAGE 20
CHECKED BY: BJK		

Reproduced from the site plan provided by the Ortho-Chevron Chemical Company.



PHOSDRIN, $\mu\text{g/l}$

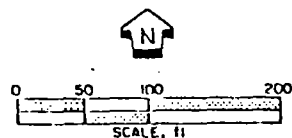
0.05 - Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Aug. '81.

(0.05) - Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Feb. '81.

NS - Indicates not sampled

ND - Indicates none detected, detection limit = $\frac{1}{2}$

OWC-1 - Groundwater well location and designation



HYDROGEOLOGY STUDY & GROUNDWATER CHARACTERISTICS
MARYLAND HEIGHTS, MISSOURI
ORTHO-CHEVRON CHEMICAL COMPANY

PROJECT NO.
SRI-5-2

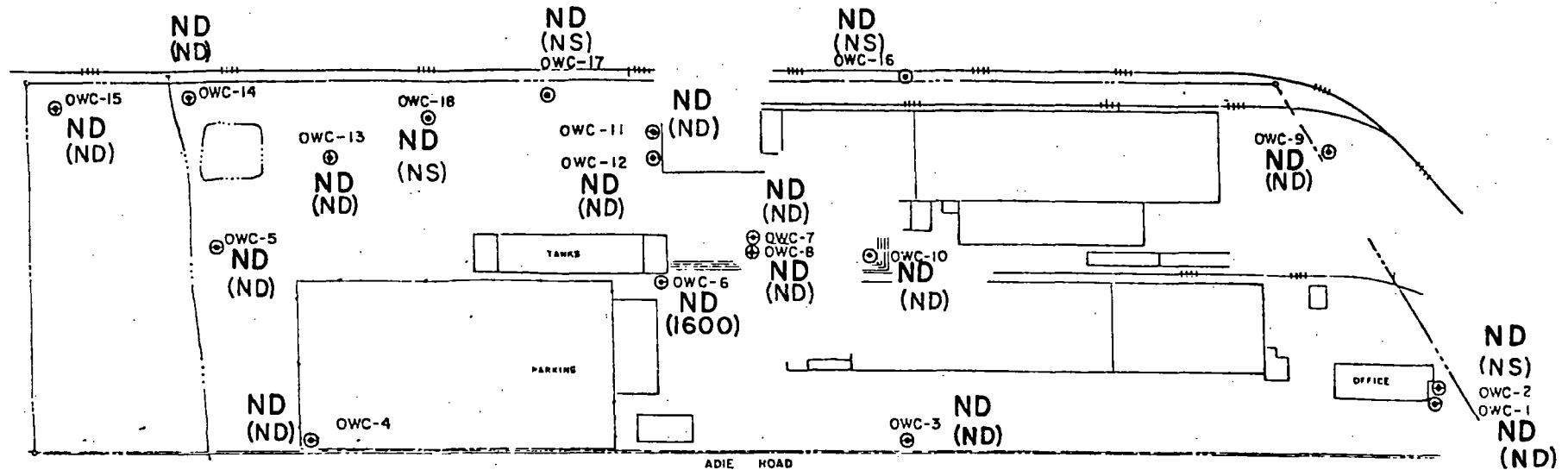
WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS
CENTRAL REGION

DRAWN BY: K.M. 9-21-81
CHECKED BY: BJK

Contaminant Distribution

FIG. NO.
21

Reproduced from the site plan provided by the Ortho-Chevron Chemical Company.



PCB, $\mu\text{g/l}$

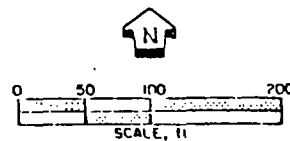
0.05 — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Aug. '81.

(0.05) — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Feb. '81.

NS — Indicates not sampled

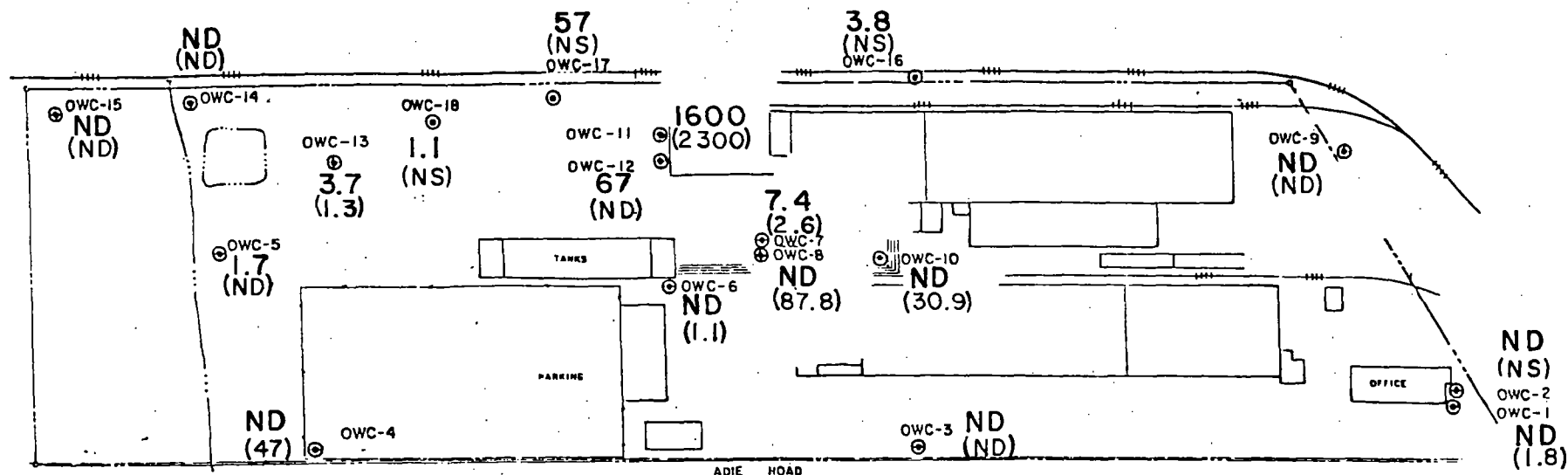
ND — Indicates none detected, detection limit = 10.0

OWC-1 — Groundwater well location and designation



HYDROGEOLOGY STUDY B GROUNDWATER CHARACTERISTICS		PRIJECT NO
MARYLAND HEIGHTS, MISSOURI		SRI-2
ORTHO-CHEVRON CHEMICAL COMPANY		
WOODWARD-CLYDE CONSULTANTS		
CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS		
CENTRAL REGION		
DATE BY: 9-21-81	Contaminant Distribution	
CHECK BY: BJK		
		FIG. 22

Reproduced from the site plan provided by the Ortho-Chevron Chemical Company.



0.05 — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Aug.'81.

(0.05) — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Feb.'81.

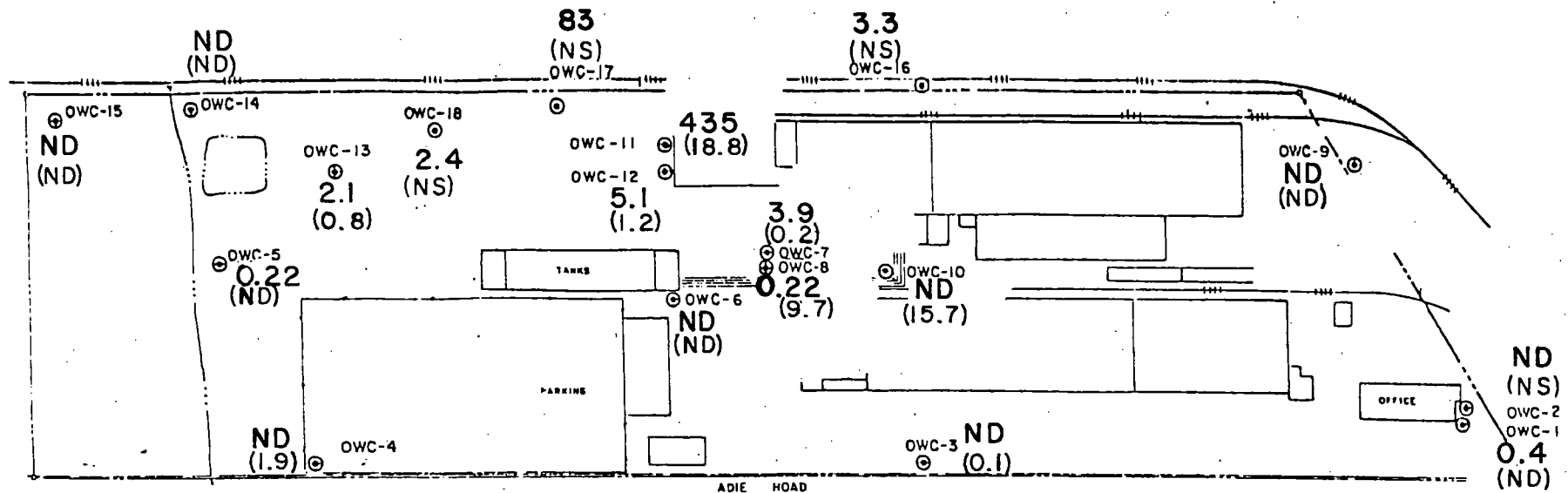
NS — Indicates not sampled

ND — Indicates none detected, detection limit = 1.0

OWC-1 — Groundwater well location and designation

HYDROGEOLOGY STUDY & GROUNDWATER CHARACTERISTICS MARTIN AND HEIGHTS, MISSOURI ORTHO-CHEVRON CHEMICAL COMPANY		PROJECT NO. SRI-5-2
WOODWARD-CLYDE CONSULTANTS CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS CENTRAL REGION		
DATE BY: K/M CHD BY: BJK	9-21-81 Contaminant Distribution	FIG. 23

Reproduced from the site plan provided by
the Ortho-Chevron Chemical Company.



2,4,5-T µg/l

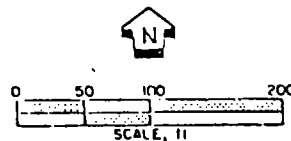
0.05 — Indicates groundwater constituent concentrations as
measured in groundwater samples obtained in Aug. '81.

(0.05) — Indicates groundwater constituent concentrations as
measured in groundwater samples obtained in Feb. '81.

NS — Indicates not sampled

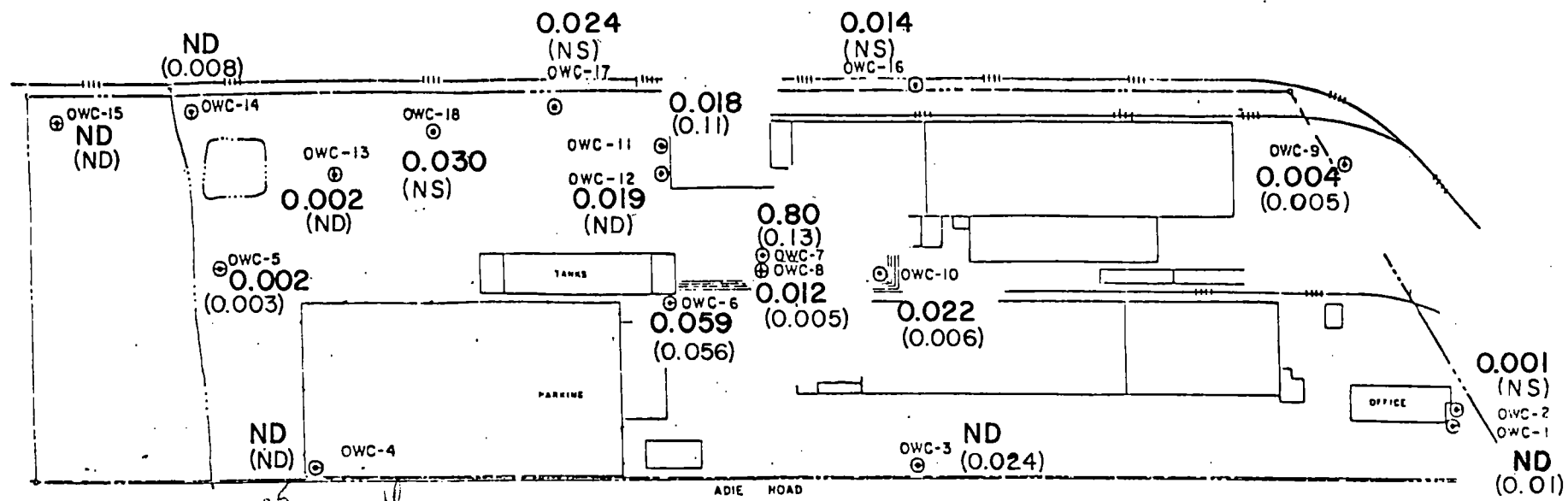
ND — Indicates none detected, detection limit = 0.1

OWC-1 — Groundwater well location and designation



HYDROGEOLOGY STUDY B GROUNDWATER CHARACTERISTICS MARYLAND HEIGHTS, MISSOURI ORTHO-CHEVRON CHEMICAL COMPANY		PROJECT NO. SRI-5-2
WOODWARD-CLYDE CONSULTANTS CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS CENTRAL REGION		
DATE BY: <i>AM</i> 9-21-81 CHECK BY: <i>PJK</i>	Contaminant Distribution	
		FILE NO. 24

Reproduced from the site plan provided by the Ortho-Chevron Chemical Company.



Handwritten notes:
 7/10/81
 22 (NS) 17.5
 22 12.5 NS 18
 20 1.75 NS 18
ARSENIC, mg / l

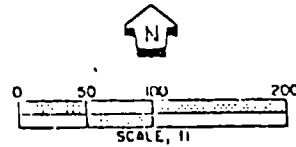
0.05 — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Aug. '81.

(0.05) — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Feb. '81.

NS — Indicates not sampled

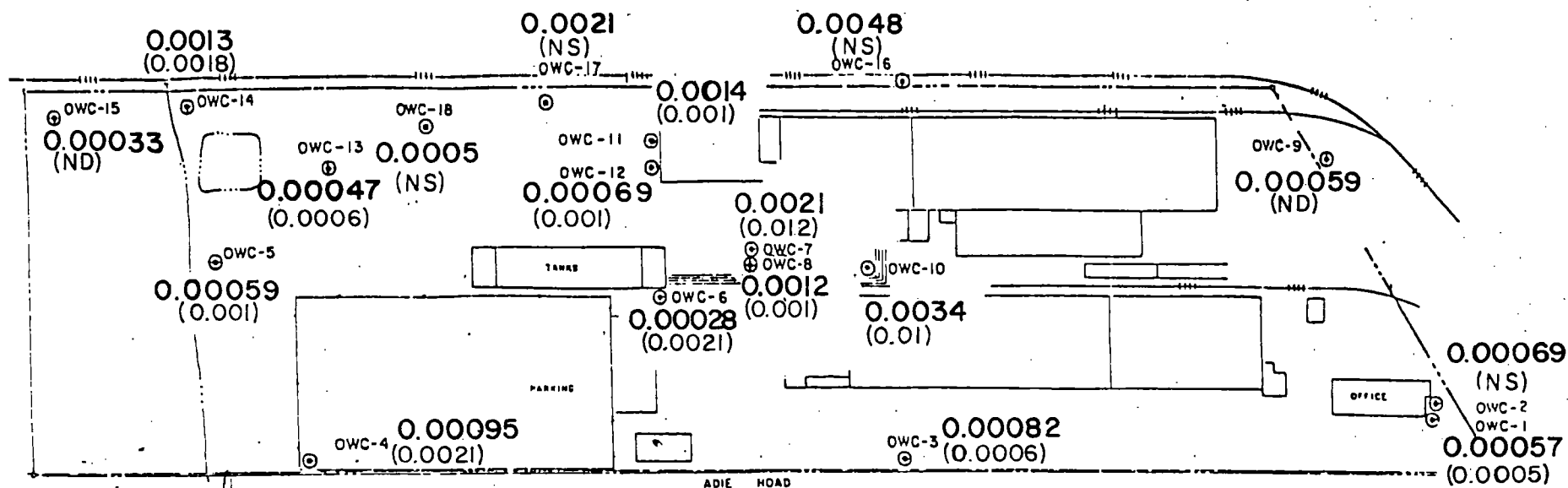
ND — Indicates none detected, detection limit = 0.001

OWC-1 — Groundwater well location and designation



HYDROGEOLOGY STUDY B GROUNDWATER CHARACTERISTICS		PROJECT NO.
MARYLAND HEIGHTS, MISSOURI		5-11-3-2
ORTHO-CHEVRON CHEMICAL COMPANY		
WOODWARD-CLYDE CONSULTANTS		
CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS		
DATE BY <i>AKM</i> 9-21-81	Contaminant Distribution	
CHD BY <i>BJK</i>	25	

Reproduced from the site plan provided by the Ortho-Chevron Chemical Company.



CADMIUM, mg/l

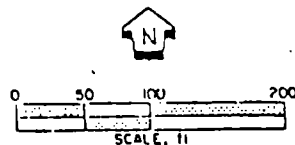
0.05 — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Aug.'81.

(0.05) — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Feb.'81.

NS — Indicates not sampled

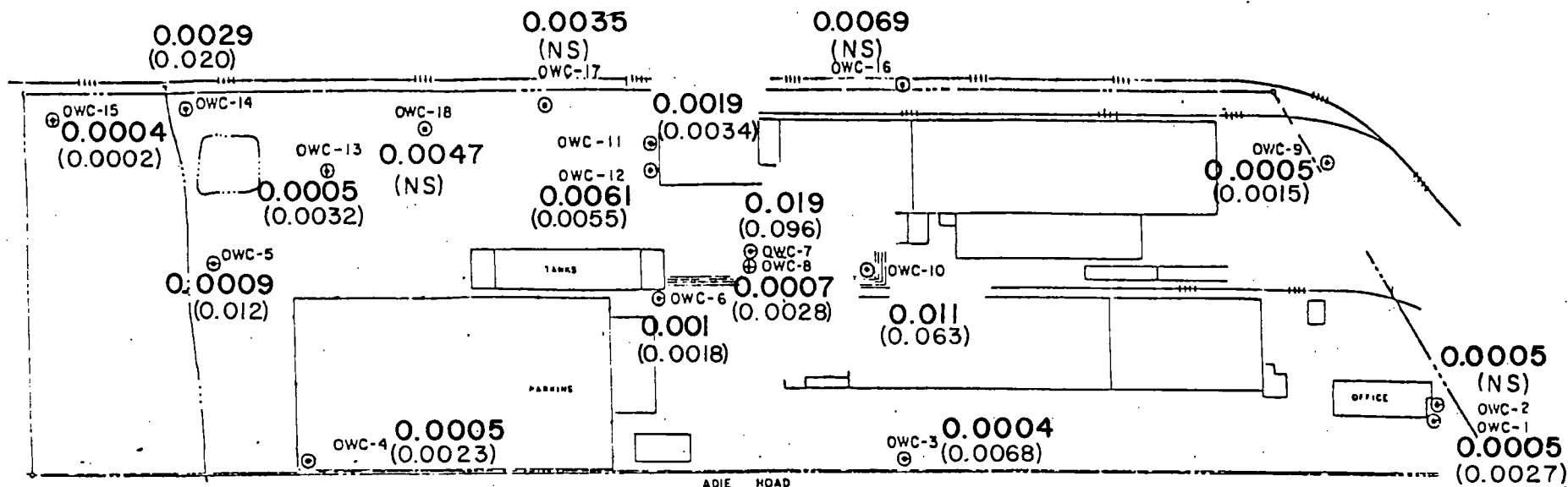
ND — Indicates none detected, detection limit = 0.0001

OWC-1 — Groundwater well location and designation



HYDROGEOLOGY STUDY & GROUNDWATER CHARACTERISTICS MARYLAND HEIGHTS, MISSOURI ORTHO-CHEVRON CHEMICAL COMPANY		PROJECT NO. 5 MI-3-2
WOODWARD-CLYDE CONSULTANTS CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS CENTRAL REGION		
DATE BY <i>AKM</i> 9-21-81	Contaminant Distribution	
CHECK BY <i>BJK</i>	26	

Reproduced from the site plan provided by the Ortho-Chevron Chemical Company.



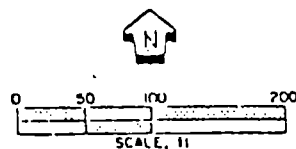
0.05 — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Aug.'81.

(0.05) — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Feb.'81.

NS — Indicates not sampled

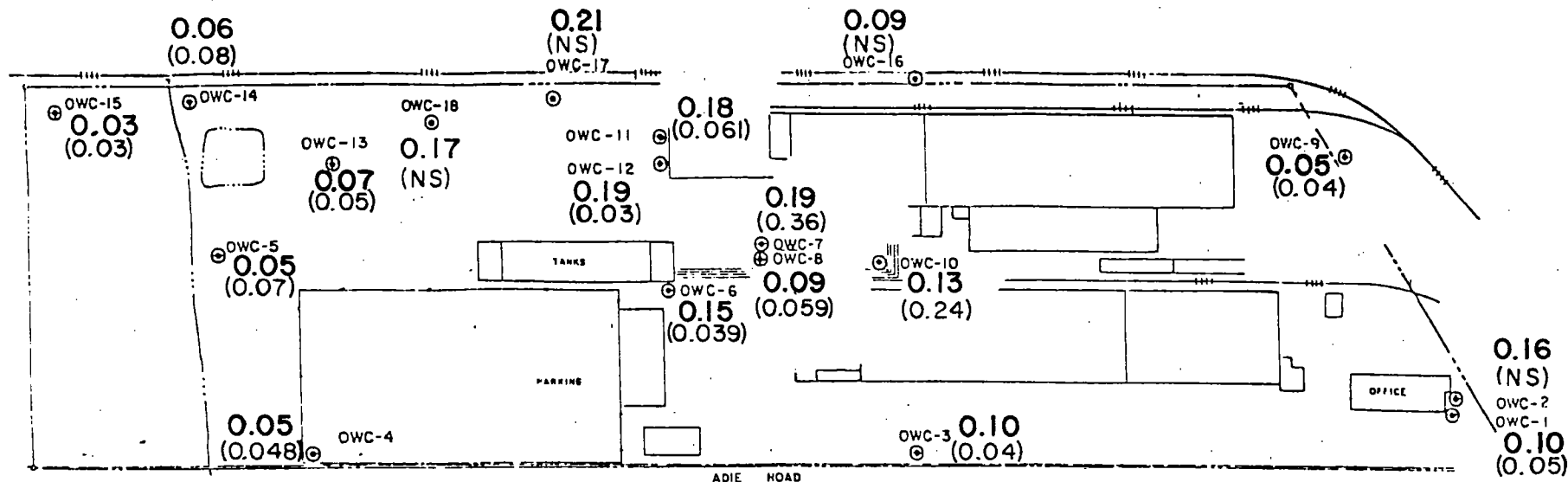
ND — Indicates none detected, detection limit =

OWC-1 — Groundwater well location and designation



HYDROGEOLOGY STUDY B GROUNDWATER CHARACTERISTICS MARYLAND HEIGHTS, MISSOURI ORTHO-CHEVRON CHEMICAL COMPANY		PROJECT NO 5 H-5-2
WOODWARD-CLYDE CONSULTANTS CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS CENTRAL REGION		
DATE: 9-21-81 DRAWN BY: BJK	Contaminant Distribution	27

Reproduced from the site plan provided by the Ortho-Chevron Chemical Company.



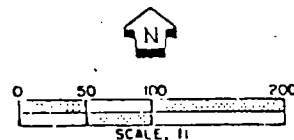
0.05 - Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Aug. '81.

(0.05) - Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Feb. '81.

NS - Indicates not sampled

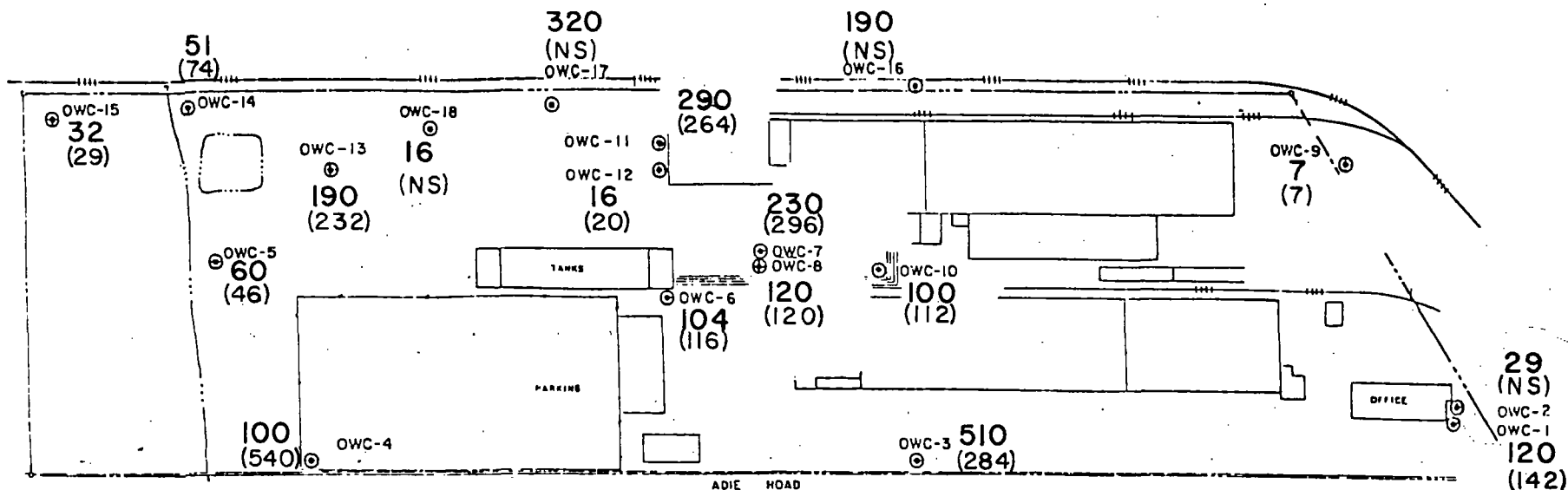
ND - Indicates none detected, detection limit =

OWC-1 - Groundwater well location and designation



HYDROGEOLOGY STUDY B GROUNDWATER CHARACTERISTICS MARYLAND HEIGHTS, MISSOURI ORTHO-CHEVRON CHEMICAL COMPANY		PROJECT NO 5 H-5-2
WOODWARD-CLYDE CONSULTANTS CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS CENTRAL REGION		
DATE: 9-21-81	FIG. NO. 28	
DRAWN BY: DJK		Contaminant Distribution

Reproduced from the site plan provided by the Ortho-Chevron Chemical Company.



CHLORIDE, mg/l

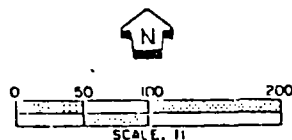
0.05 - Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Aug. '81.

(0.05) - Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Feb. '81.

NS - Indicates not sampled

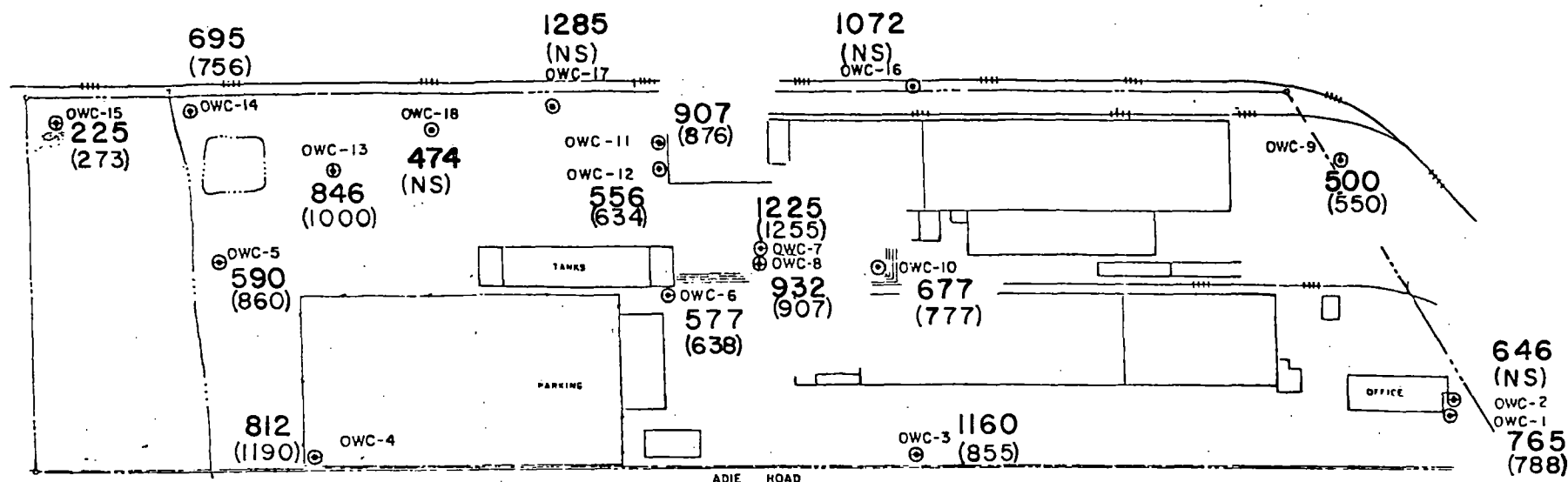
ND - Indicates none detected, detection limit =

OWC-1 - Groundwater well location and designation



HYDROGEOLOGY STUDY & GROUNDWATER CHARACTERISTICS MARYLAND HEIGHTS, MISSOURI ORTHO-CHEVRON CHEMICAL COMPANY		PROJECT NO. SM-5-2
WOODWARD-CLYDE CONSULTANTS CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS CENTRAL REGION		
DATE BY: J.M.	9-21-81	FIG. NO. 29
CHECKED BY: BJK	Contaminant Distribution	

Reproduced from the site plan provided by
the Ortho-Chevron Chemical Company.



DISSOLVED SOLIDS, - mg/l

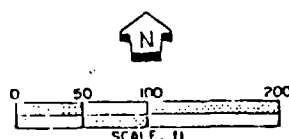
0.05 - Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Aug. '81.

(0.05) - Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Feb. '81.

NS - Indicates not sampled

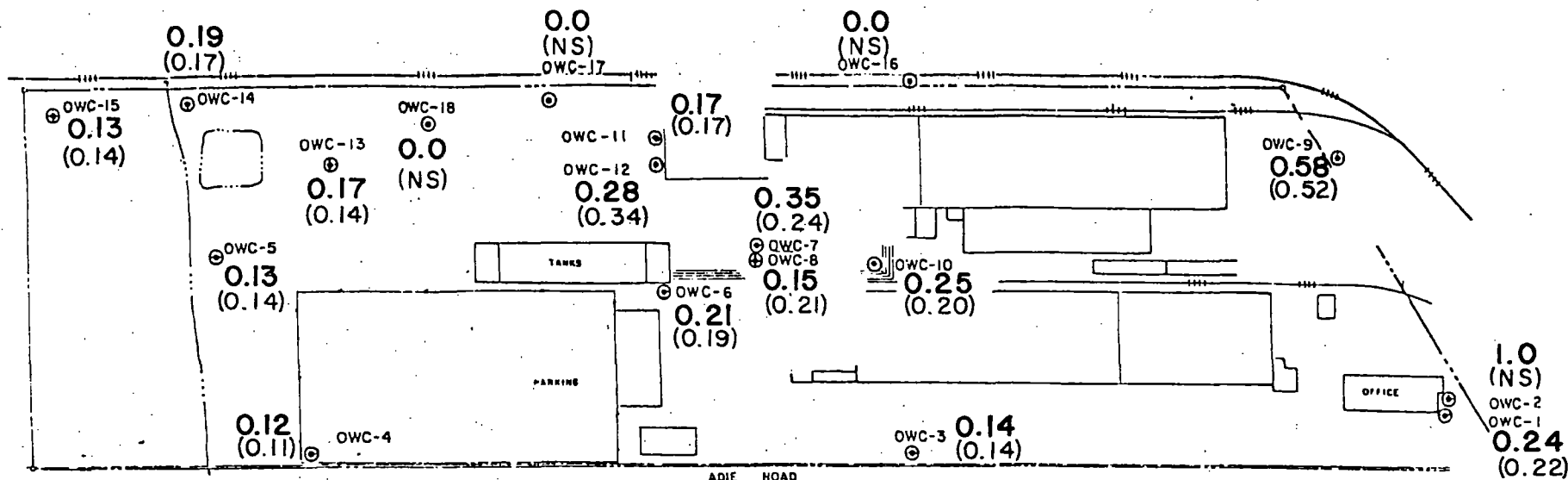
ND - Indicates none detected, detection limit =

OWC-1 - Groundwater well location and designation



HYDROGEOLOGY STUDY & GROUNDWATER CHARACTERISTICS MARYLAND HEIGHTS, MISSOURI ORTHO-CHEVRON CHEMICAL COMPANY		PROJECT NO. RI-5-2
WOODWARD-CLYDE CONSULTANTS CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS CENTRAL REGION		
DATE: 9-21-81	FIG. 30	
CHECKED BY: DJK	Contaminant Distribution	

Reproduced from the site plan provided by the Ortho-Chevron Chemical Company.



FLUORIDE, mg/l

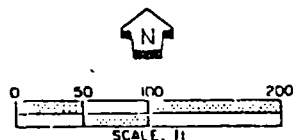
0.05 - Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Aug. '81.

(0.05) - Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Feb. '81.

NS - Indicates not sampled

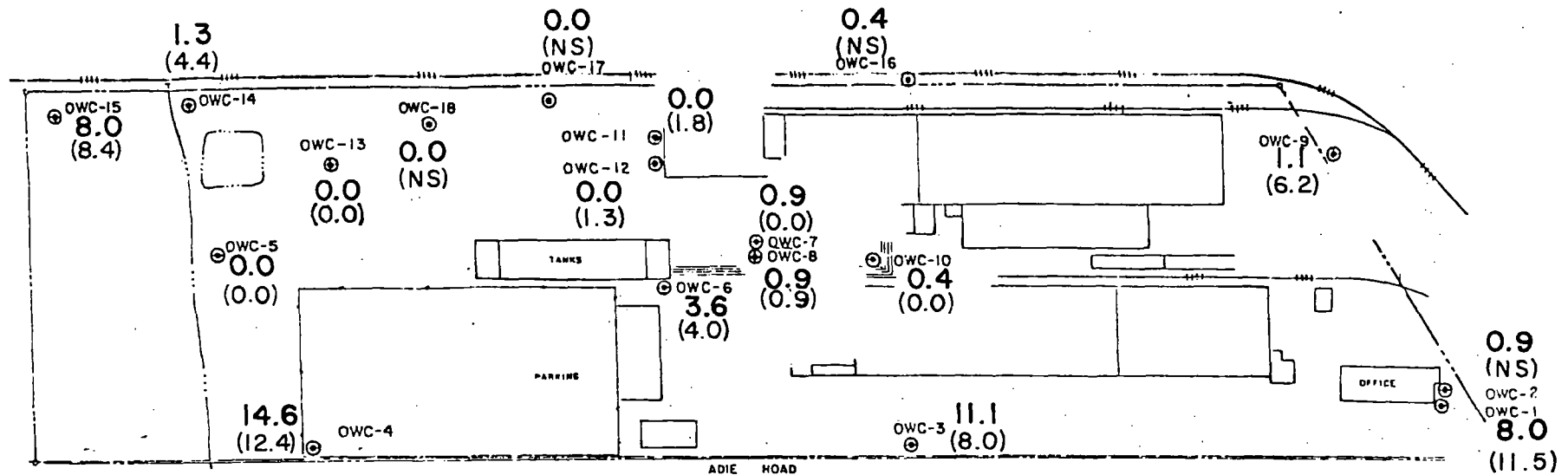
ND - Indicates none detected, detection limit =

OWC-1 - Groundwater well location and designation



HYDROGEOLOGY STUDY B GROUNDWATER CHARACTERISTICS MARYLAND HEIGHTS, MISSOURI ORTHO-CHEVRON CHEMICAL COMPANY		PROJECT NO SRI-5-2
WOODWARD-CLYDE CONSULTANTS CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS CENTRAL OFFICE		
DATE BY: PJM CHECK BY: PJK	9-21-81 Contaminant Distribution	PAGE NO 31

Reproduced from the site plan provided by
the Ortho-Chevron Chemical Company.



NITRATE (as NO_3^-), mg/l

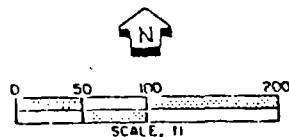
0.05 — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Aug. '81.

(0.05) — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Feb. '81.

NS — Indicates not sampled

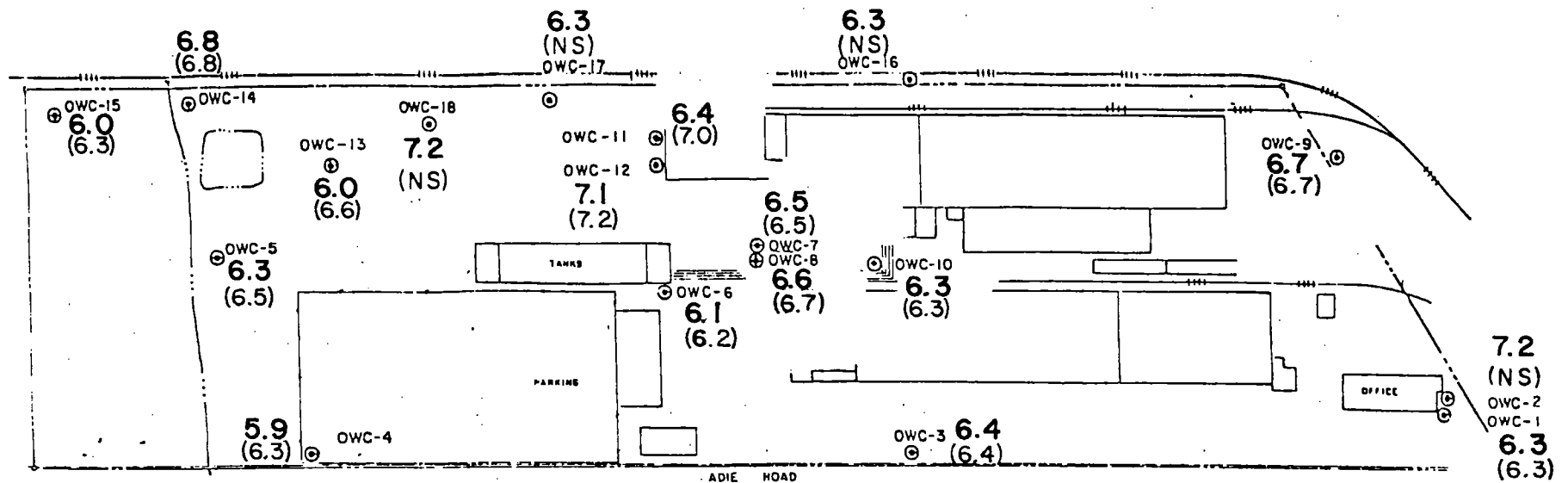
ND — Indicates none detected, detection limit =

OWC-1 — Groundwater well location and designation



HYDROGEOLOGY STUDY B GROUNDWATER CHARACTERISTICS MARYLAND HEIGHTS, MISSOURI ORTHO-CHEVRON CHEMICAL COMPANY		PROJECT NO. 9-21-81
WOODWARD-CLYDE CONSULTANTS CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS CENTRAL REGION		FILE NO. 32
DRAWN BY CHKD BY	9-21-81 PJL	Contaminant Distribution

Reproduced from the site plan provided by the Ortho-Chevron Chemical Company.



* pH, pH units

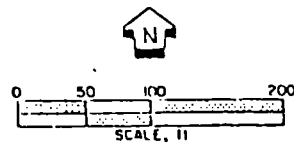
0.05 — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Aug. '81.

(0.05) — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Feb. '81.

NS — Indicates not sampled.

ND — Indicates none detected, detection limit =

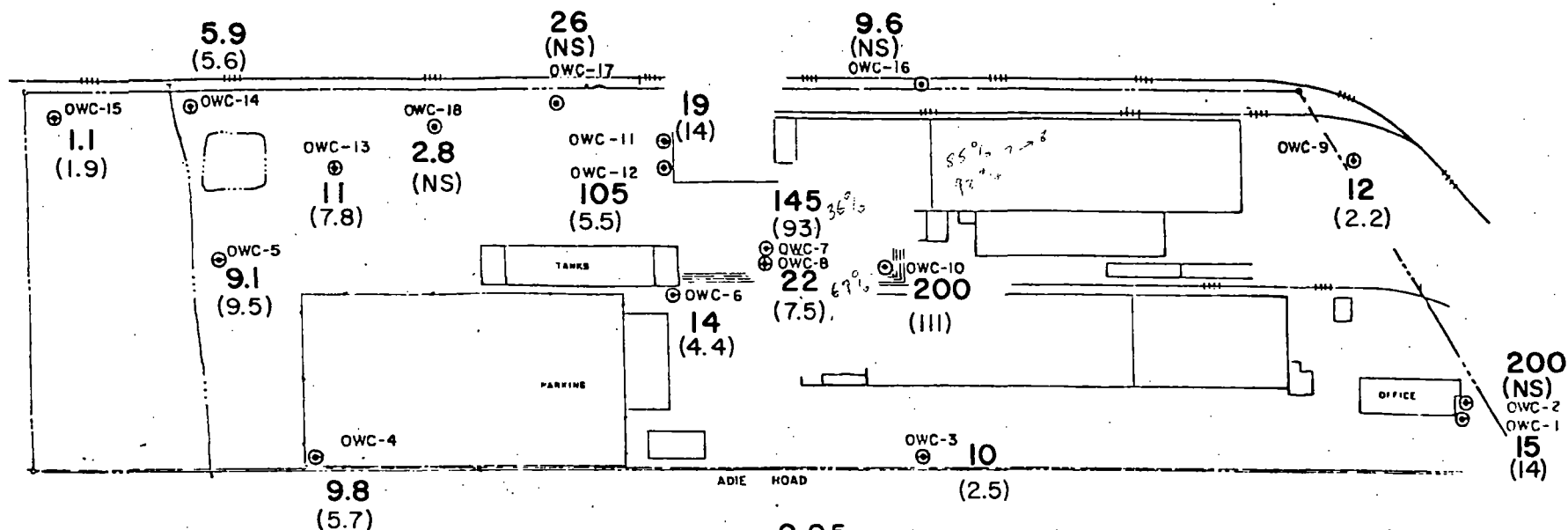
OWC-1 — Groundwater well location and designation



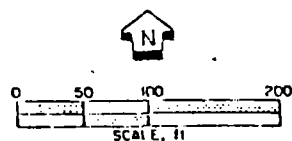
* as measured in the field during sampling

HYDROGEOLOGY STUDY & GROUNDWATER CHARACTERISTICS MARYLAND HEIGHTS, MISSOURI ORTHO-CHEVRON CHEMICAL COMPANY		PROJECT NO. RI-5-2
WOODWARD-CLYDE CONSULTANTS CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS CENTRAL REGION		
DATE: 9-21-81 CHECKED BY: BJK	Contaminant Distribution	33

Reproduced from the site plan provided by the Ortho-Chevron Chemical Company.



TOTAL ORGANIC CARBON
mg/l



0.05 — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Aug. '81.

(0.05) — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Feb. '81.

NS — Indicates not sampled

ND — Indicates none detected, detection limit =

OWC-1 — Groundwater well location and designation

HYDROGEOLOGY STUDY & GROUNDWATER CHARACTERISTICS
MARYLAND HEIGHTS, MISSOURI
ORTHO-CHEVRON CHEMICAL COMPANY

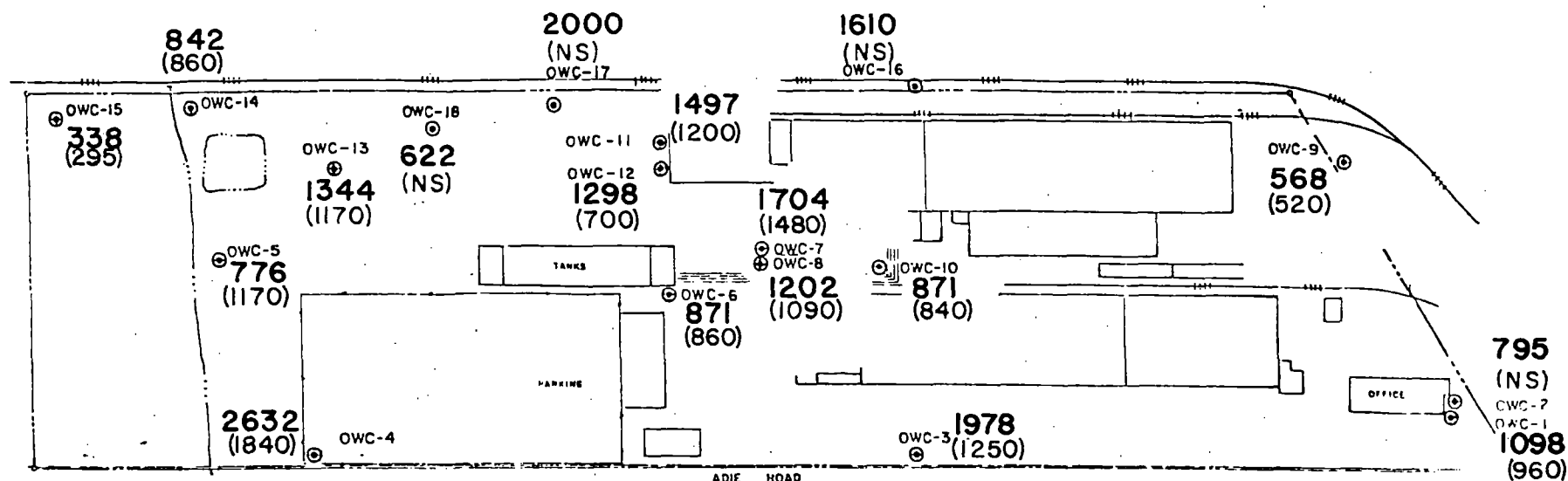
WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS
CENTRAL REGION

DRAWN BY: *[Signature]* 9-21-81
CHECKED BY: *[Signature]*

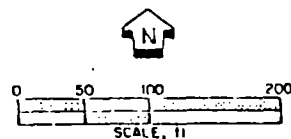
Contaminant Distribution

FIG. 34

Reproduced from the site plan provided by the Ortho-Chevron Chemical Company.



SPECIFIC CONDUCTIVITY
μmhos/cm



0.05 — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Aug. '81.

(0.05) — Indicates groundwater constituent concentrations as measured in groundwater samples obtained in Feb. '81.

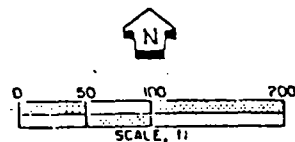
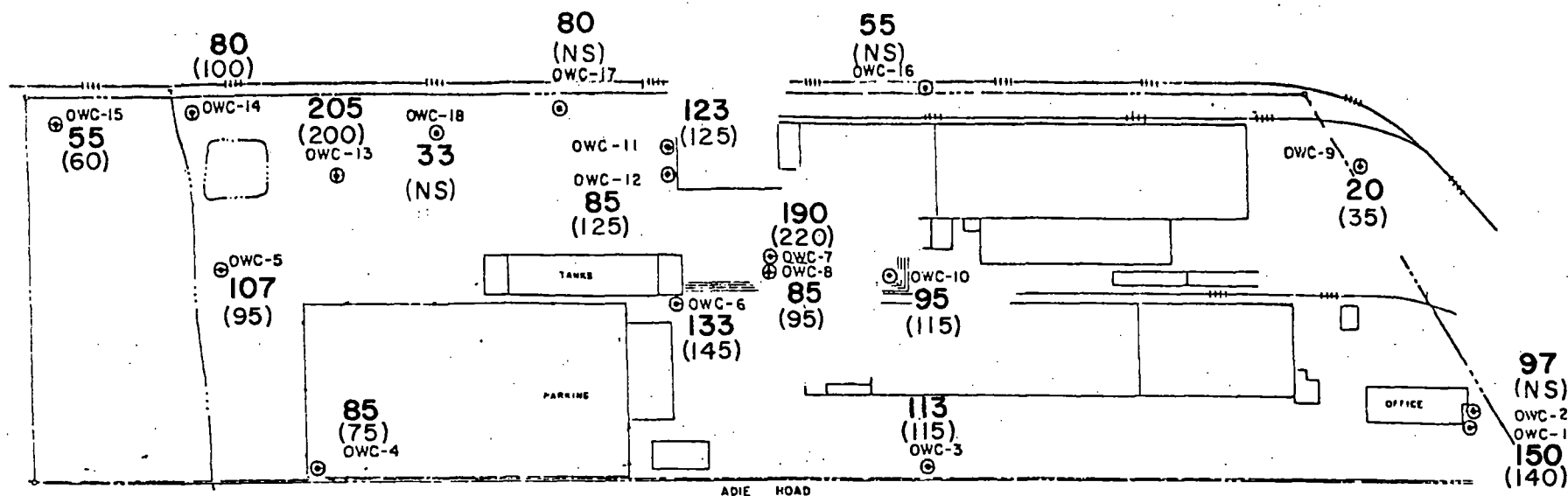
NS — Indicates not sampled

ND — Indicates none detected, detection limit =

OWC-1 — Groundwater well location and designation

HYDROGEOLOGY STUDY & GROUNDWATER CHARACTERISTICS MARYLAND HEIGHTS, MISSOURI ORTHO-CHEVRON CHEMICAL COMPANY		PROJECT NO. RI-2
WOODWARD-CLYDE CONSULTANTS CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS CENTRAL REGION		
DRAWN BY: <i>AK</i>	DATE: 9-21-81	FIG. NO. 35
CHECKED BY: <i>AK</i>	Contaminant Distribution	

Reproduced from the site plan provided by the Ortho-Chevron Chemical Company.



HYDROGEOLOGY STUDY & GROUNDWATER CHARACTERISTICS MARYLAND HEIGHTS, MISSOURI ORTHO-CHEVRON CHEMICAL COMPANY		PROJECT NO S RI-3-2
WOODWARD-CLYDE CONSULTANTS CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS CENTRAL OFFICE		
DATE BY: KJM 9-21-81	Contaminant Distribution	FILE NO 36
CHECK BY: DJK		

APPENDIX A

BORING LOG

LEGEND AND NOMENCLATURE

Items shown on boring logs refer to the following:


1. Depth - Depth below reference elevation, ground surface unless otherwise shown.
2. Sample - Types designated by letter
 - D - Disturbed sample, obtained from auger cuttings or wash water for classification purposes only.
 - S - Split-Spoon sample, obtained by driving 2-inch split-spoon to determine penetration resistance and allow classification.
 - C - Liner tube sample, obtained by penetration of thick, wall sampler containing 2-inch diameter liner-tubes (California sampler).
 - U - Undisturbed sample, obtained by penetration of minimum 3 inch diameter, thin-wall tube using an open or, where indicated, fixed-piston sampling head.

Rec - Recovery is expressed as a ratio of the length recovered to the total length pushed or driven (in inches) i.e. $\frac{8}{12}$

Resist - Resistance is designated as follows:

- P - Sample pushed in one continuous movement by hydraulic rig action, maximum hydraulic pressure shown where pertinent.
- ³₆₉ - Numbers indicate blows per 6 inches of sampler penetration when driven by a 140-pound hammer falling freely 30 inches. The Standard Penetration Resistance is the number of blows for the last 12 inches of penetration of the split-spoon sampler, e.g. 15. Note that a blow count can be given for the California sampler, but this is not the Standard Penetration Resistance.
3. Description - Description of material according to the Unified Soil Classification: word description gives soil constituents, consistency or density, and other appropriate classification characteristics. Unified Soil Classification symbols are shown on the USC column. Geologic names, where appropriate, are shown under Special Notes. A solid line indicates stratigraphic change; a dashed line indicates approximate location of stratigraphic change.
4. Special Notes and Field Observations - Pertinent observations made by inspector during drilling including type of boring, free water level, water seepage, fluid loss, hole termination depth, etc.
5. Legend -

CFA - Continuous flight auger
ATD - At time of drilling
AD - After drilling
DWL - Drill water loss
DWR - Drill water return


Water depth at specified time after drilling
Water entry depth at time of drilling

BORING LOG

SHEET 1 OF 1

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5-2

OWC-16

PROJECT LOCATION St. Louis, Mo.

DATE 7-31-81

LOGGED BY P. Barrett DRILLED BY G. Schanning

RIG CME-75

SURFACE ELEVATION 522+ ELEVATION DATUM USC & GS

WATER ENTERS El. 511+
ATD

DEPTH	SAMPLE			DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
	TYPE	REC	RESIST			
0				Firm, brown, silty Clay FILL with gravel and concrete	FILL	Boring advanced with 6" diameter hollow stem auger with 8" bit
5				Firm to stiff, dark gray, low to medium plastic Silty CLAY	CL	
				Becoming mottled gray and brown		
10				Becoming stiff, brown		← Water detected ATD
15				Becoming medium to highly plastic	CL CH	
20						Bottom of boring 19.0'
25						

BORING LOG

PROJECT NAME ORTHO CHEVRON

SHEET 1 OF 1

PROJECT NO. S81-5-2

OWC-17

PROJECT LOCATION St. Louis, Mo.

DATE 7-31-81

RIG CME-75

LOGGED BY P. Barrett DRILLED BY G. Schanning

WATER ENTERS El. 509-

SURFACE ELEVATION 522 ELEVATION DATUM USC & GS

ATD

DEPTH	SAMPLE			DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
	TYPE	REC	RESIST			
0				Stiff, brown, silty Clay FILL with black cinders and organics	FILL	Boring advanced with 6" diameter hollow stem auger with 8" bit
5	C	$\frac{10}{12}$	P			
				Stiff, mottled gray and brown, low to medium plastic Silty CLAY with organics	CL	
10	C	$\frac{12}{12}$	P			
				Becoming firm to stiff, brown		← Water detected ATD
15	C	$\frac{12}{12}$	P			
				Becoming stiffer, more plastic		
20						Bottom of boring 18.0'
25						

BORING LOG

PROJECT NAME ORTHO CHEVRON

SHEET 1 OF 4

PROJECT NO. S81-5-2

OWC-18

PROJECT LOCATION St. Louis, Mo.

DATE 7-27-81

RIG CME-75

LOGGED BY P. Barrett DRILLED BY G. Schanning

WATER ENTERS El. 510

SURFACE ELEVATION 519 ELEVATION DATUM USC & GS

ATD

DEPTH	SAMPLE			DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
	TYPE	REC	RESIST			
0				Firm, brown, low plastic silty Clay FILL	FILL	Boring advanced with 6" diameter hollow stem auger with 8" bit
	C	$\frac{12}{12}$	P			
5				With fine sand and gravel		
	C	$\frac{10}{12}$	P			
				Stiff, mottled gray, medium plastic Silty CLAY with organics	CL	← Water detected ATD
10						
	C	$\frac{7}{12}$	P			
				Becoming light gray and tan-brown		
15						
	C	$\frac{12}{12}$	P			
				Becoming medium tan and brown		
20						
	C	$\frac{12}{12}$	P			
				Becoming very stiff, highly plastic	CH	
25						

BORING LOG

PROJECT NAME ORTHO CHEVRON

SHEET 2 OF 4

PROJECT NO. S81-5-2

OWC-18

PROJECT LOCATION St. Louis, Mo.

DATE 7-27-81

LOGGED BY P. Barrett DRILLED BY G. Schanning

RIG CME-75

SURFACE ELEVATION 519 ELEVATION DATUM USC & GS

WATER ENTERS E1. 510

ATD

DEPTH	SAMPLE			DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
	TYPE	REC	RESIST			
25				SAME: Very stiff, tan and brown, highly plastic Silty CLAY	CH	Casing set to 27.0'
				LIMESTONE: Light gray, very weathered, intermixed with highly plastic CLAY	LS & CH	(Drilling hard in places) Boring continued with NX double tube core barrel with diamond bit and water
30	NX RUN #1	60 78	RQD 22 78	LIMESTONE: Gray, weathered and fractured with horizontal seams, vertical seams and some chert zones	LS	NX RUN #1 Start: 30.0' Stop: 36.5' Run: 6.5' Rec: 5.0' Coring Rate: 6 min./ft. DWR: 90%
		77%	28%			
35						
	NX RUN #2	100 102	RQD 63 102	Becoming less weathered with only horizontal fractures, and less chert		NX RUN #2 Start: 36.5' Stop: 45.0' Run: 8.5' Rec: 8.3' Coring Rate: 6 min./ft. DWR: 98%
		98%	62%			
40						
45	NX RUN #3	88 90	RQD 58 90	With vertical fracture		NX RUN #3 Start: 45.0' Stop: 52.5' Run: 7.5' Rec: 7.3' Coring Rate: 6 min./ft. DWR: 98%
		98%	64%			
50						

BORING LOG

SHEET 3 OF 4

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5-2

OWC-18

PROJECT LOCATION St. Louis, Mo.

DATE 8/27-8/28/81

LOGGED BY P. Barrett DRILLED BY G. Schanning

RIG CME-75

SURFACE ELEVATION 519 ELEVATION DATUM USC & GS

WATER ENTERS El. 510

ATD

DEPTH	SAMPLE			DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
	TYPE	REC	RESIST			
50				SAME: LIMESTONE: Gray, slightly weathered with some horizontal fractures and little chert	LS	
	NX RUN #4	$\frac{85}{90}$	$\frac{RQD}{39/90}$			NX RUN #4 Start: 52.5' Stop: 60.0' Run: 7.5' Rec: 7.1' Coring Rate: 5.5 min./ft. DWR: 95%
55		94%	43%			
60	NX RUN #5	$\frac{108}{120}$	$\frac{RQD}{22.5/120}$			NX RUN #5 Start: 60.0' Stop: 70.0' Run: 10.0' Rec: 9.0' Coring Rate: 6 min./ft. DWR: 95%
		90%	19%			
65						
70	NX RUN #6	$\frac{60}{60}$	$\frac{RQD}{44/60}$	With vertical fractures		NX RUN #6 Start: 70.0' Stop: 75.0' Run: 5.0' Rec: 5.0' Coring Rate: 6 min./ft. DWR: 98%
		100%	73%			
75						

BORING LOG

SHEET 4 OF 4

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5-2

DATE 7-29-81

RIG CME-75

WATER ENTERS E1. 510

ATD

SURFACE ELEVATION 519 ELEVATION DATUM USC & GS

[illegible]

APPENDIX B

PIEZOMETER INSTALLATION REPORT

Project ORTHO CHEVRON Piezometer No. OWC-16
 Location St. Louis, Mo.
 Project No. S81-5-2 Installed By P. Barrett Date 7-31-81 Time PM

Method of Installation Well screen and riser pipe installed immediately after the augers were removed from the boring. Drilling fluid was not required.

LOG OF BORING AND PIEZOMETER		
BORING		PIEZOMETER
Depth in ft.	Description	Symbol
0	Firm, brown, silty Clay FILL with gravel and concrete	F
10	Firm, stiff, dark gray, low to medium plastic Silty CLAY Becoming mottled gray and brown Becoming stiff, brown Becoming more plastic	CL CL CH
20	Bottom of boring 19.0'	
30		
40		
50		

Type of Piezometer PVC Observation well

Ground Elev. 522.5 Top of Riser Elev. 524.2

(Protective casing)
Vented Cap

I.D. of Riser Pipe 4.0 in.
Type of Pipe PVC

Type of Backfill Around Riser Cement-Bentonite Grout

Top of Seal Elev. 519.5
Type of Seal Material Peltonite

Top of Filter Elev. 515.5
Type of Filter Material Washed river sand
Size of Openings 0.02 in.
Diameter of Piezometer Tip 4.0 in.
Bottom of Piez. Elev. 503.5
Bottom of Boring Elev. 503.5
Diameter of Boring 8.0 in.

$L_1 = 1.0'$
 $L_2 = 3.0'$
 $L_3 = 4.0'$
 $L_4 = 12.0'$
 $L_5 = 10.0'$
 $L_6 = 10.0'$
 $L_7 = 19.0'$

Remarks _____

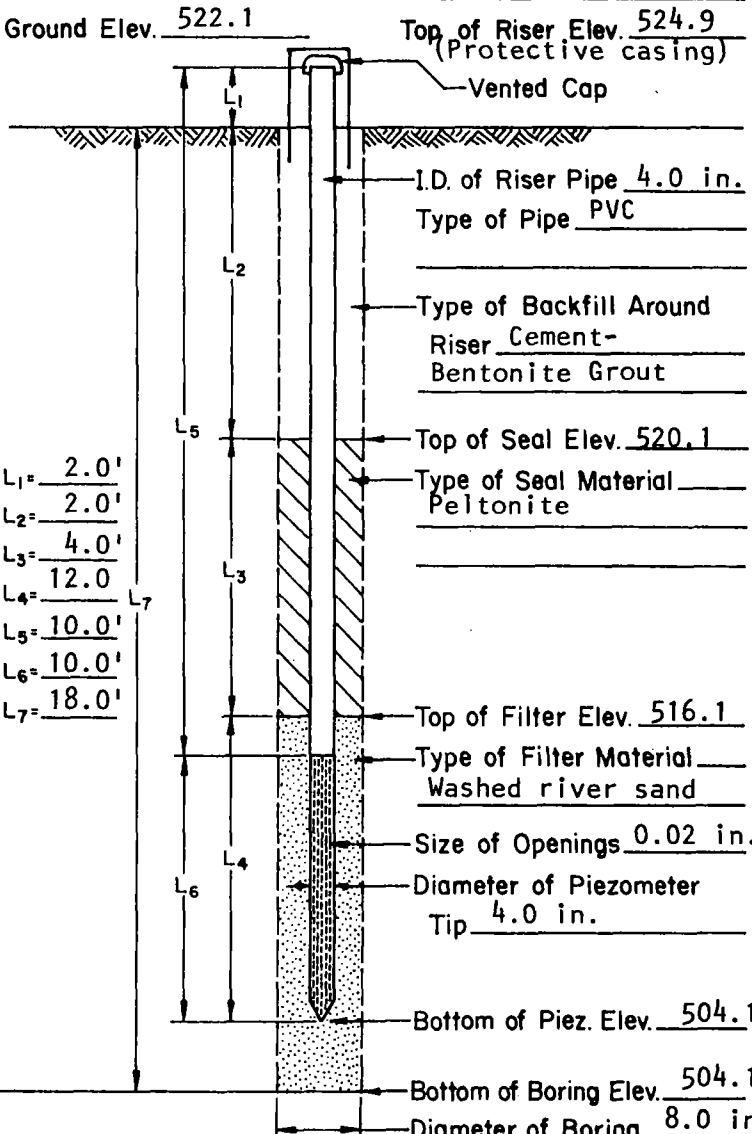
Inspected By Peter Barrett
 WOODWARD-CLYDE CONSULTANTS

PIEZOMETER INSTALLATION REPORT

Project ORTHO CHEVRON Piezometer No. OWC-17
 Location St. Louis, Mo.
 Project No. S81-5-2 Installed By P. Barrett Date 7-31-81 Time AM

Method of Installation Well screen and riser pipe were installed immediately after the augers were removed from the boring. Drilling fluid was not required.

LOG OF BORING AND PIEZOMETER

BORING			PIEZOMETER	
			Type of Piezometer <u>PVC Observation well</u>	
Depth in ft.	Description	Symbol	<div style="display: flex; justify-content: space-between;"> Ground Elev. <u>522.1</u> Top of Riser Elev. <u>524.9</u> (Protective casing) </div>  <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>$L_1 = \frac{2.0'}{2.0'}$</p> <p>$L_2 = \frac{4.0'}{12.0'}$</p> <p>$L_3 = \frac{10.0'}{10.0'}$</p> <p>$L_4 = \frac{10.0'}{18.0'}$</p> <p>$L_5 = \frac{10.0'}{18.0'}$</p> <p>$L_6 = \frac{10.0'}{18.0'}$</p> <p>$L_7 = \frac{18.0'}{18.0'}$</p> </div> <div style="width: 50%;"> <p>Vented Cap</p> <p>I.D. of Riser Pipe <u>4.0 in.</u></p> <p>Type of Pipe <u>PVC</u></p> <p>Type of Backfill Around Riser <u>Cement-Bentonite Grout</u></p> <p>Top of Seal Elev. <u>520.1</u></p> <p>Type of Seal Material <u>Peltonite</u></p> <p>Top of Filter Elev. <u>516.1</u></p> <p>Type of Filter Material <u>Washed river sand</u></p> <p>Size of Openings <u>0.02 in.</u></p> <p>Diameter of Piezometer Tip <u>4.0 in.</u></p> <p>Bottom of Piez. Elev. <u>504.1</u></p> <p>Bottom of Boring Elev. <u>504.1</u></p> <p>Diameter of Boring <u>8.0 in.</u></p> </div> </div>	
0	Stiff, brown, silty Clay FILL with black cinders and organics	FILL		
10	Stiff, mottled gray and brown, low to medium plastic Silty CLAY with organics Becoming firm to stiff, brown Becoming stiff, more plastic	CL		
20	Bottom of boring 18.0'			
30				
40				
50				

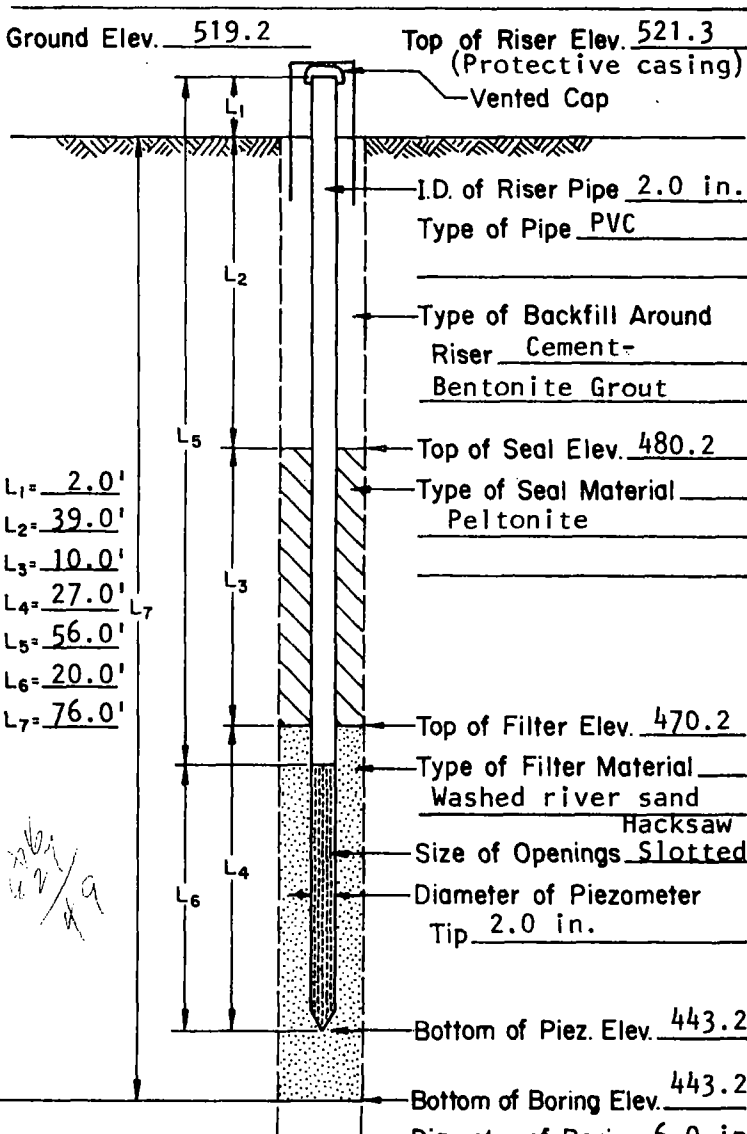
Remarks _____

Inspected By Peter Barrett

PIEZOMETER INSTALLATION REPORT

Project ORTHO CHEVRON Piezometer No. OWC-18
 Project No. S81-5-2 Installed By P. Barrett & P. Knotts Location St. Louis, Mo.
 Date 7-30-81 Time _____
 Method of Installation NX-size double tube core barrel was used to core limestone. Drilling fluid was clean water which was recirculated through a mud pit. After the limestone was cored the hole was reamed to 6" diameter with a roller bit. Well screen consists of 20.0' of PVC pipe slotted with a hacksaw.

LOG OF BORING AND PIEZOMETER

BORING			PIEZOMETER	
			Type of Piezometer	<u>PVC Observation well</u>
Depth in ft.	Description	Symbol	Ground Elev. <u>519.2</u>	Top of Riser Elev. <u>521.3</u> (Protective casing) Vented Cap
0	Firm, brown, low plastic Silty Clay FILL with sand and gravel	FILL	 <p> I.D. of Riser Pipe <u>2.0 in.</u> Type of Pipe <u>PVC</u> Type of Backfill Around Riser <u>Cement-Bentonite Grout</u> Top of Seal Elev. <u>480.2</u> Type of Seal Material <u>Peltonite</u> Top of Filter Elev. <u>470.2</u> Type of Filter Material <u>Washed river sand</u> <u>Hacksaw</u> Size of Openings <u>Slotted</u> Diameter of Piezometer Tip <u>2.0 in.</u> Bottom of Piez. Elev. <u>443.2</u> Bottom of Boring Elev. <u>443.2</u> Diameter of Boring <u>6.0 in.</u> </p>	
10	Stiff, mottled gray, medium plastic Silty CLAY with organics	CL		
	Becoming light gray and brown			
	Becoming medium tan and brown			
20	Becoming very stiff, highly plastic	CL		
	With weathered limestone	CH		
30	LIMESTONE: Gray, weathered with horizontal and vertical fractures and chert zones	LS		
40	Becoming less weathered, less fractured, less cherty		<p> <i>2061 621 49</i> </p>	
	With fractures			
50	Bottom of boring 76.0'			

Remarks _____

Inspected By Peter Barrett
 WOODWARD - CLYDE CONSULTANTS

APPENDIX C

CHEMICAL WATER ANALYSIS
ORGANIC PESTICIDES AND METALS

Parameters	8107-0406 OWC-1 Chevron	8107-0407 OWC-2 Chevron	8107-0408 OWC-3 Chevron	8107-0409 OWC-4 Chevron
Total Organic Carbon, mg/l	15	200	10	9.8
Phosdrin (Mevinphos), ug/l	ND(1.0)	ND(1.0)	ND(1.0)	ND(1.0)
Diazinon, ug/l	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)
Parathion, Methyl, ug/l	ND(1.0)	ND(1.0)	ND(1.0)	ND(1.0)
Malathion, ug/l	ND(1.0)	ND(1.0)	ND(1.0)	ND(1.0)
Parathion, Ethyl, ug/l	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)
Trithion, ug/l	ND(100)	ND(100)	ND(100)	ND(100)
Guthion, ug/l	ND(100)	ND(100)	ND(100)	ND(100)
2,4-D, ug/l	ND(1.0)	ND(1.0)	ND(1.0)	ND(1.0)
2,4,5-TP, ug/l	0.40	ND(0.1)	ND(0.1)	ND(0.1)
Lindane, ug/l	0.15	0.23	0.30	ND(0.10)
Heptachlor, ug/l	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)
Aldrin, ug/l	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)
4,4-DDE, ug/l	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)
Dieldrin, ug/l	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)
Captan, ug/l	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)
Endrin, ug/l	ND(0.40)	ND(0.40)	ND(0.40)	ND(0.40)
Chlorobenzilate, ug/l	ND(0.30)	ND(0.30)	ND(0.30)	ND(0.30)
4,4-DDD, ug/l	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)
4,4-DDT, ug/l	ND(0.30)	ND(0.30)	ND(0.30)	ND(0.30)
Mirex, ug/l	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)
Difolatan, ug/l	ND(20)	ND(20)	ND(20)	ND(20)
Methoxychlor, ug/l	ND(0.80)	ND(0.80)	ND(0.80)	ND(0.80)
Chlordane, ug/l	ND(1.0)	ND(1.0)	ND(1.0)	ND(1.0)
Toxaphene, ug/l	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)
PCB 1221, ug/l	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)
PCB 1232, ug/l	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)
PCB 1242, ug/l	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)
PCB 1248, ug/l	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)
PCB 1254, ug/l	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)
PCB 1260, ug/l	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)
Kelthane, ug/l	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)
Arsenic, mg/l	ND(0.001)	0.001	ND(0.001)	ND(0.001)
Copper, mg/l	0.0005	0.0005	0.0004	0.0005
Zinc, mg/l	0.10	0.16	0.10	0.05
Cadmium, mg/l	0.00057	0.00069	0.00082	0.00095

ND denotes none detected. The detection limit of the method is shown in parentheses.



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CHEMICAL WATER ANALYSIS
ORGANIC PESTICIDES AND METALS

<u>Parameters</u>	<u>8107-0386</u> <u>OWC-5</u> <u>Chevron</u>	<u>8107-0410</u> <u>OWC-6</u> <u>Chevron</u>	<u>8107-0411</u> <u>OWC-7</u> <u>Chevron</u>
Total Organic Carbon, mg/l	9.1	14	145
Phosdrin (Mevinphos), ug/l	ND(1.0)	ND(1.0)	ND(1.0)
Diazinon, ug/l	ND(0.5)	5.8	ND(0.5)
Parathion, Methyl, ug/l	ND(1.0)	ND(1.0)	ND(1.0)
Malathion, ug/l	ND(1.0)	4.1	ND(1.0)
Parathion, Ethyl, ug/l	ND(0.5)	ND(0.5)	ND(0.5)
Trithion, ug/l	ND(100)	ND(100)	ND(100)
Guthion, ug/l	ND(100)	ND(100)	ND(100)
2,4-D, ug/l	1.7	ND(1.0)	7.4
2,4,5-TP, ug/l	0.22	ND(0.1)	3.9
Lindane, ug/l	0.26	5.78	410
Heptachlor, ug/l	ND(0.20)	ND(0.20)	ND(0.20)
Aldrin, ug/l	ND(0.20)	ND(0.20)	26
4,4-DDE, ug/l	ND(0.20)	ND(0.20)	ND(0.20)
Diieldrin, ug/l	ND(0.20)	1.46	6.25
Captan, ug/l	ND(0.20)	ND(0.20)	ND(0.20)
Endrin, ug/l	ND(0.40)	ND(0.40)	ND(0.40)
Chlorobenzilate, ug/l	ND(0.30)	ND(0.30)	ND(0.30)
4,4-DDD, ug/l	ND(0.20)	0.99	12.3
4,4-DDT, ug/l	ND(0.30)	ND(0.30)	8.8
Mirex, ug/l	ND(0.50)	ND(0.50)	ND(0.50)
Difolatan, ug/l	ND(20)	ND(20)	ND(20)
Methoxychlor, ug/l	ND(0.80)	ND(0.80)	ND(0.80)
Chlordane, ug/l	ND(1.0)	ND(1.0)	ND(1.0)
Toxaphene, ug/l	ND(10.0)	ND(10.0)	ND(10.0)
PCB 1221, ug/l	ND(10.0)	ND(10.0)	ND(10.0)
PCB 1232, ug/l	ND(10.0)	ND(10.0)	ND(10.0)
PCB 1242, ug/l	ND(10.0)	ND(10.0)	ND(10.0)
PCB 1248, ug/l	ND(10.0)	ND(10.0)	ND(10.0)
PCB 1254, ug/l	ND(10.0)	ND(10.0)	ND(10.0)
PCB 1260, ug/l	ND(10.0)	ND(10.0)	ND(10.0)
Kelthane, ug/l	ND(10.0)	ND(10.0)	ND(10.0)
Arsenic, mg/l	0.002	0.059	0.80
Cadmium, mg/l	0.00059	0.00028	0.0021
Copper, mg/l	0.0009	0.0010	0.019
Zinc, mg/l	0.05	0.15	0.19

ND denotes none detected. The detection limit of the method is shown in parentheses.



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CHEMICAL WATER ANALYSIS
ORGANIC PESTICIDES AND METALS

Parameters	8107-0412 OWC-8 Chevron	8107-0413 OWC-9 Chevron	8107-0414 OWC-10 Chevron	8107-0387 OWC-11 Chevron
Total Organic Carbon, mg/l	22	12	200	19
Phosdrin (Mevinphos), ug/l	ND(1.0)	ND(1.0)	ND(1.0)	ND(1.0)
Diazinon, ug/l	0.78	ND(0.5)	8.7	1.6
Parathion, Methyl, ug/l	ND(1.0)	ND(1.0)	ND(1.0)	ND(1.0)
Malathion, ug/l	ND(1.0)	ND(1.0)	ND(1.0)	ND(1.0)
Parathion, Ethyl, ug/l	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)
Trithion, ug/l	ND(100)	ND(100)	ND(100)	ND(100)
Guthion, ug/l	ND(100)	ND(100)	ND(100)	ND(100)
2,4-D, ug/l	ND(1.0)	ND(1.0)	ND(1.0)	1600
2,4,5-TP, ug/l	0.22	ND(0.1)	ND(0.1)	435
Lindane, ug/l	32.6	0.45	10.0	64
Heptachlor, ug/l	ND(0.20)	ND(0.20)	0.52	ND(0.20)
Aldrin, ug/l	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)
4,4-DDE, ug/l	ND(0.20)	0.19	ND(0.20)	ND(0.20)
Diieldrin, ug/l	ND(0.20)	0.41	1.01	22
Captan, ug/l	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)
Endrin, ug/l	ND(0.40)	ND(0.40)	ND(0.40)	ND(0.40)
Chlorobenzilate, ug/l	ND(0.30)	ND(0.30)	ND(0.30)	ND(0.30)
4,4-DDD, ug/l	ND(0.20)	0.91	ND(0.20)	2.6
4,4-DDT, ug/l	ND(0.30)	0.84	ND(0.30)	0.81
Mirex, ug/l	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)
Difolatan, ug/l	ND(20)	ND(20)	ND(20)	ND(20)
Methoxychlor, ug/l	ND(0.80)	ND(0.80)	ND(0.80)	ND(0.80)
Chlordane, ug/l	ND(1.0)	ND(1.0)	ND(1.0)	ND(1.0)
Toxaphene, ug/l	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)
PCB 1221, ug/l	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)
PCB 1232, ug/l	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)
PCB 1242, ug/l	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)
PCB 1248, ug/l	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)
PCB 1254, ug/l	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)
PCB 1260, ug/l	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)
Kelthane, ug/l	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)
Arsenic, mg/l	0.012	0.004	0.022	0.018
Copper, mg/l	0.0007	0.0005	0.011	0.0019
Zinc, mg/l	0.09	0.05	0.13	0.18
Cadmium, mg/l	0.0012	0.00059	0.0034	0.0014

ND denotes none detected. The detection limit of the method is shown in parentheses.



CHEMICAL WATER ANALYSIS
ORGANIC PESTICIDES AND METALS

<u>Parameters</u>	8107-0388 OWC-12 Chevron	8107-0389 OWC-13 Chevron	8107-0390 OWC-14 Chevron	8107-0391 OWC-15 Chevron
Total Organic Carbon, mg/l	105	11	5.9	1.1
Phosdrin (Mevinphos), ug/l	0.88	3.1	ND(1.0)	ND(1.0)
Diazinon, ug/l	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)
Parathion, Methyl, ug/l	ND(1.0)	ND(1.0)	ND(1.0)	ND(1.0)
Malathion, ug/l	ND(1.0)	ND(1.0)	ND(1.0)	ND(1.0)
Parathion, Ethyl, ug/l	48	ND(0.5)	ND(0.5)	ND(0.5)
Trithion, ug/l	ND(100)	ND(100)	ND(100)	ND(100)
Guthion, ug/l	ND(100)	ND(100)	ND(100)	ND(100)
2,4-D, ug/l	67	3.7	ND(1.0)	ND(1.0)
2,4,5-TP, ug/l	5.1	2.10	ND(0.1)	ND(0.1)
Lindane, ug/l	32	234	3.56	0.38
Heptachlor, ug/l	0.25	2.43	ND(0.20)	ND(0.20)
Aldrin, ug/l	2.30	ND(0.20)	ND(0.20)	ND(0.20)
4,4-DDE, ug/l	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)
Diieldrin, ug/l	1.51	ND(0.20)	ND(0.20)	ND(0.20)
Captan, ug/l	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)
Endrin, ug/l	ND(0.40)	ND(0.40)	ND(0.40)	ND(0.40)
Chlorobenzilate, ug/l	ND(0.30)	ND(0.30)	ND(0.30)	ND(0.30)
4,4-DDD, ug/l	ND(0.20)	1.40	ND(0.20)	ND(0.20)
4,4-DDT, ug/l	0.65	ND(0.30)	ND(0.30)	ND(0.30)
Mirex, ug/l	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)
Difolatan, ug/l	ND(20)	ND(20)	ND(20)	ND(20)
Methoxychlor, ug/l	ND(0.80)	ND(0.80)	ND(0.80)	ND(0.80)
Chlordane, ug/l	ND(1.0)	ND(1.0)	ND(1.0)	ND(1.0)
Toxaphene, ug/l	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)
PCB 1221, ug/l	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)
PCB 1232, ug/l	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)
PCB 1242, ug/l	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)
PCB 1248, ug/l	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)
PCB 1254, ug/l	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)
PCB 1260, ug/l	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)
Kelthane, ug/l	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)
Arsenic, mg/l	0.019	0.002	ND(0.001)	ND(0.001)
Cadmium, mg/l	0.00069	0.00047	0.0013	0.00033
Copper, mg/l	0.0061	0.0005	0.0029	0.0004
Zinc, mg/l	0.19	0.07	0.06	0.03

ND denotes none detected. The detection limit of the method is shown in parentheses.



WILSON LABORATORIES
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CHEMICAL WATER ANALYSIS
ORGANIC PESTICIDES AND METALS

<u>Parameters</u>	8108-0198 OWC-16 Chevron	8108-0199 OWC-17 Chevron	8108-0200 OWC-18 Chevron
Total Organic Carbon, mg/l	9.6	26	2.8
Phosdrin (Mevinphos), ug/l	ND(1.0)	ND(1.0)	ND(1.0)
Diazinon, ug/l	0.63	ND(0.5)	0.84
Parathion, Methyl, ug/l	ND(1.0)	ND(1.0)	ND(1.0)
Malathion, ug/l	ND(1.0)	ND(1.0)	ND(1.0)
Parathion, Ethyl, ug/l	ND(0.5)	ND(0.5)	ND(0.5)
Trithion, ug/l	ND(100)	ND(100)	ND(100)
Guthion, ug/l	ND(100)	ND(100)	ND(100)
2,4-D, ug/l	3.8	57	1.1
2,4,5-TP, ug/l	3.3	83	2.4
Lindane, ug/l	0.91	62.0	58.0
Heptachlor, ug/l	2.0	ND(0.20)	ND(0.20)
Aldrin, ug/l	ND(0.20)	ND(0.20)	0.77
4,4-DDE, ug/l	ND(0.20)	1.22	ND(0.20)
Diieldrin, ug/l	0.27	1.55	1.20
Captan, ug/l	ND(0.20)	ND(0.20)	ND(0.20)
Endrin, ug/l	ND(0.40)	ND(0.40)	ND(0.40)
Chlorobenzilate, ug/l	ND(0.30)	ND(0.30)	ND(0.30)
4,4-DDD, ug/l	ND(0.20)	1.66	0.77
4,4-DDT, ug/l	ND(0.30)	0.62	0.45
Mirex, ug/l	ND(0.50)	ND(0.50)	ND(0.50)
Difolatan, ug/l	ND(20)	ND(20)	ND(20)
Methoxychlor, ug/l	ND(0.80)	ND(0.80)	ND(0.80)
Chlordane, ug/l	ND(1.0)	ND(1.0)	ND(1.0)
Toxaphene, ug/l	ND(10.0)	ND(10.0)	ND(10.0)
PCB 1221, ug/l	ND(10.0)	ND(10.0)	ND(10.0)
PCB 1232, ug/l	ND(10.0)	ND(10.0)	ND(10.0)
PCB 1242, ug/l	ND(10.0)	ND(10.0)	ND(10.0)
PCB 1248, ug/l	ND(10.0)	ND(10.0)	ND(10.0)
PCB 1254, ug/l	ND(10.0)	ND(10.0)	ND(10.0)
PCB 1260, ug/l	ND(10.0)	ND(10.0)	ND(10.0)
Kelthane, ug/l	ND(10.0)	ND(10.0)	ND(10.0)
Arsenic, mg/l	0.014	0.024	0.030
Copper, mg/l	0.0069	0.0035	0.0047
Zinc, mg/l	0.09	0.21	0.17
Cadmium, mg/l	0.0048	0.0021	0.00050

ND denotes none detected. The detection limit of the method is shown in parentheses.



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STANDARD CHEMICAL WATER ANALYSIS

SAMPLE: OWC-1 CHEVRON

CATIONS				LABORATORY ANALYSIS
CALCIUM	CA+2	MG/L		116.00
IRON, TOTAL	FE+2	MG/L		0.05
MAGNESIUM	MG+2	MG/L		52.00
MANGANESE	MN+2	MG/L		0.95
POTASSIUM	K +1	MG/L		1.30
SODIUM	NA+1	MG/L		48.00
ANIONS				
BICARBONATE	HC03-1	MG/L		231.64
CARBONATE	C03 -2	MG/L		0.07
CHLORIDE	CL -1	MG/L		120.00
FLUORIDE	F -1	MG/L		0.24
HYDROXIDE	OH -1	MG/L		0.00
NITRATE	NO3 -1	MG/L		7.97
PHOSPHATE	P04 -3	MG/L		0.00
SULFATE	S04 -2	MG/L		150.00
SILICATE	SIO4-4	MG/L		0.03
SILICA		SIO2	MG/L	40.66
TOTAL FREE CARBON DIOXIDE		CO2	MG/L	273.39
EQUILIBRIUM CARBON DIOXIDE		CO2	MG/L	31.24
TOTAL DISSOLVED SOLIDS (CALC)			MG/L	765.12
TOTAL ALKALINITY	AS	CAC03	MG/L	189.94
CALCIUM ALKALINITY	AS	CAC03	MG/L	189.94
MAGNESIUM ALKALINITY	AS	CAC03	MG/L	0.00
SODIUM ALKALINITY	AS	CAC03	MG/L	0.00
TOTAL HARDNESS	AS	CAC03	MG/L	503.30
CALCIUM HARDNESS	AS	CAC03	MG/L	290.00
MAGNESIUM HARDNESS	AS	CAC03	MG/L	213.72
NON-CARBONATE HARDNESS	AS	CAC03	MG/L	313.36
CALCIUM NON-CARBONATE HARDNESS			MG/L	100.06
MAGNESIUM NON-CARBONATE HARDNESS			MG/L	213.72
PH		PH	UNITS	6.48
EQUILIBRIUM PH (PHS)		PH	UNITS	7.24
STABILITY INDEX		PH	UNITS	8.01
SATURATION INDEX		PH	UNITS	-0.76
TEMPERATURE	DEGREES	FAHRENHEIT		68.00
CONDUCTIVITY, MEASURED		MICROMHOS/CM		1098.00
IONIC STRENGTH (MOLAR)				0.0180
ION BALANCE ERROR (PERCENT) ACTIVITY CORRECTED				-0.83

STANDARD CHEMICAL WATER ANALYSIS
SAMPLE: OWC-2 CHEVRON

CATIONS			LABORATORY ANALYSIS
CALCIUM	CA+2	MG/L	80.00
IRON, TOTAL	FE+2	MG/L	3.10
MAGNESIUM	MG+2	MG/L	38.00
MANGANESE	MN+2	MG/L	1.61
POTASSIUM	K +1	MG/L	2.40
SODIUM	NA+1	MG/L	40.00

ANIONS

BICARBONATE	HCO3-1	MG/L	340.29
CARBONATE	CO3 -2	MG/L	0.60
CHLORIDE	CL -1	MG/L	29.00
FLUORIDE	F -1	MG/L	1.00
HYDROXIDE	OH -1	MG/L	0.00
NITRATE	NO3 -1	MG/L	0.89
PHOSPHATE	PO4 -3	MG/L	0.00
SULFATE	SO4 -2	MG/L	97.00
SILICATE	SIO4-4	MG/L	0.07

SILICA	SI02	MG/L	17.12
TOTAL FREE CARBON DIOXIDE	CO2	MG/L	61.52
EQUILIBRIUM CARBON DIOXIDE	CO2	MG/L	48.77
TOTAL DISSOLVED SOLIDS (CALC)		MG/L	645.50
TOTAL ALKALINITY	AS CAC03	MG/L	279.87
CALCIUM ALKALINITY	AS CAC03	MG/L	200.00
MAGNESIUM ALKALINITY	AS CAC03	MG/L	79.87
SODIUM ALKALINITY	AS CAC03	MG/L	0.00
TOTAL HARDNESS	AS CAC03	MG/L	355.89
CALCIUM HARDNESS	AS CAC03	MG/L	200.00
MAGNESIUM HARDNESS	AS CAC03	MG/L	156.18
NON-CARBONATE HARDNESS	AS CAC03	MG/L	76.02
CALCIUM NON-CARBONATE HARDNESS		MG/L	0.00
MAGNESIUM NON-CARBONATE HARDNESS		MG/L	76.31
PH	PH UNITS		7.28
EQUILIBRIUM PH (PHS)	PH UNITS		7.23
STABILITY INDEX	PH UNITS		7.17
SATURATION INDEX	PH UNITS		0.05
TEMPERATURE	DEGREES FAHRENHEIT		68.00
CONDUCTIVITY, MEASURED	MICROMHOS/CM		795.00
IONIC STRENGTH (MOLAR)			0.0135
ION BALANCE ERROR (PERCENT) BY CONCENTRATION			3.33

STANDARD CHEMICAL WATER ANALYSIS

SAMPLE: OWC-3 CHEVRON

CATIONS				LABORATORY ANALYSIS
CALCIUM	CA+2	MG/L		163.00
IRON, TOTAL	FE+2	MG/L		0.07
MAGNESIUM	MG+2	MG/L		65.00
MANGANESE	MN+2	MG/L		0.60
POTASSIUM	K +1	MG/L		1.30
SODIUM	NA+1	MG/L		142.00
ANIONS				
BICARBONATE	HCO3-1	MG/L		121.88
CARBONATE	CO3 -2	MG/L		0.05
CHLORIDE	CL -1	MG/L		510.00
FLUORIDE	F -1	MG/L		0.14
HYDROXIDE	OH -1	MG/L		0.00
NITRATE	NO3 -1	MG/L		11.07
PHOSPHATE	PO4 -3	MG/L		0.00
SULFATE	SO4 -2	MG/L		113.00
SILICATE	SIO4-4	MG/L		0.02
SILICA		SIO2	MG/L	34.24
TOTAL FREE CARBON DIOXIDE		CO2	MG/L	152.67
EQUILIBRIUM CARBON DIOXIDE		CO2	MG/L	11.37
TOTAL DISSOLVED SOLIDS (CALC)			MG/L	1160.38
TOTAL ALKALINITY	AS	CACO3	MG/L	99.94
CALCIUM ALKALINITY	AS	CACO3	MG/L	99.94
MAGNESIUM ALKALINITY	AS	CACO3	MG/L	0.00
SODIUM ALKALINITY	AS	CACO3	MG/L	0.00
TOTAL HARDNESS	AS	CACO3	MG/L	674.03
CALCIUM HARDNESS	AS	CACO3	MG/L	407.50
MAGNESIUM HARDNESS	AS	CACO3	MG/L	267.15
NON-CARBONATE HARDNESS	AS	CACO3	MG/L	574.09
CALCIUM NON-CARBONATE HARDNESS			MG/L	307.56
MAGNESIUM NON-CARBONATE HARDNESS			MG/L	267.15
PH		PH	UNITS	6.48
EQUILIBRIUM PH (PHS)		PH	UNITS	7.39
STABILITY INDEX		PH	UNITS	8.31
SATURATION INDEX		PH	UNITS	-0.91
TEMPERATURE	DEGREES	FAHRENHEIT		68.00
CONDUCTIVITY, MEASURED		MICROMHOS/CM		1978.00
IONIC STRENGTH (MOLAR)				0.0273
ION BALANCE ERROR (PERCENT) BY CONCENTRATION				2.04

STANDARD CHEMICAL WATER ANALYSIS
SAMPLE: OWC-4 CHEVRON

CATIONS	LABORATORY ANALYSIS
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CALCIUM	CA+2	MG/L	200.00
IRON, TOTAL	FE+2	MG/L	0.16
MAGNESIUM	MG+2	MG/L	64.00
MANGANESE	MN+2	MG/L	0.49
POTASSIUM	K +1	MG/L	2.00
SODIUM	NA+1	MG/L	230.00

ANIONS

BICARBONATE	HCO3-1	MG/L	85.38
CARBONATE	CO3 -2	MG/L	0.01
CHLORIDE	CL -1	MG/L	100.00
FLUORIDE	F -1	MG/L	0.12
HYDROXIDE	OH -1	MG/L	0.00
NITRATE	NO3 -1	MG/L	14.62
PHOSPHATE	PO4 -3	MG/L	0.00
SULFATE	SO4 -2	MG/L	85.00
SILICATE	SIO4-4	MG/L	0.01

SILICA	SIO2	MG/L	32.10
TOTAL FREE CARBON DIOXIDE	CO2	MG/L	282.85
EQUILIBRIUM CARBON DIOXIDE	CO2	MG/L	6.96
TOTAL DISSOLVED SOLIDS (CALC)		MG/L	812.49
TOTAL ALKALINITY	AS CACO3	MG/L	69.94
CALCIUM ALKALINITY	AS CACO3	MG/L	69.94
MAGNESIUM ALKALINITY	AS CACO3	MG/L	0.00
SODIUM ALKALINITY	AS CACO3	MG/L	0.00
TOTAL HARDNESS	AS CACO3	MG/L	762.23
CALCIUM HARDNESS	AS CACO3	MG/L	500.00
MAGNESIUM HARDNESS	AS CACO3	MG/L	263.04
NON-CARBONATE HARDNESS	AS CACO3	MG/L	692.29
CALCIUM NON-CARBONATE HARDNESS		MG/L	430.06
MAGNESIUM NON-CARBONATE HARDNESS		MG/L	263.04
PH	PH UNITS		6.05
EQUILIBRIUM PH (PHS)	PH UNITS		7.45
STABILITY INDEX	PH UNITS		8.86
SATURATION INDEX	PH UNITS		-1.40
TEMPERATURE	DEGREES FAHRENHEIT		68.00
CONDUCTIVITY, MEASURED	MICROMHOS/CM		2632.00
IONIC STRENGTH (MOLAR)			0.0243

STANDARD CHEMICAL WATER ANALYSIS
SAMPLE: OWC-5 CHEVRON

CATIONS

CALCIUM	CA+2	MG/L	87.00
IRON, TOTAL	FE+2	MG/L	0.25
MAGNESIUM	MG+2	MG/L	19.30
MANGANESE	MN+2	MG/L	0.75
POTASSIUM	K +1	MG/L	0.70
SODIUM	NA+1	MG/L	46.00

LABORATORY
ANALYSIS

ANIONS

BICARBONATE	HC03-1	MG/L	225.48
CARBONATE	CO3 -2	MG/L	0.09
CHLORIDE	CL -1	MG/L	60.00
FLUORIDE	F -1	MG/L	0.13
HYDROXIDE	OH -1	MG/L	0.00
NITRATE	NO3 -1	MG/L	0.00
PHOSPHATE	PO4 -3	MG/L	1.87
SULFATE	SO4 -2	MG/L	107.00
SILICATE	SI04-4	MG/L	0.04

SILICA	SI02	MG/L	44.94
TOTAL FREE CARBON DIOXIDE	CO2	MG/L	175.41
EQUILIBRIUM CARBON DIOXIDE	CO2	MG/L	23.62
TOTAL DISSOLVED SOLIDS (CALC)		MG/L	589.86
TOTAL ALKALINITY	AS CAC03	MG/L	184.92
CALCIUM ALKALINITY	AS CAC03	MG/L	184.92
MAGNESIUM ALKALINITY	AS CAC03	MG/L	0.00
SODIUM ALKALINITY	AS CAC03	MG/L	0.00
TOTAL HARDNESS	AS CAC03	MG/L	296.45
CALCIUM HARDNESS	AS CAC03	MG/L	217.50
MAGNESIUM HARDNESS	AS CAC03	MG/L	79.32
NON-CARBONATE HARDNESS	AS CAC03	MG/L	111.53
CALCIUM NON-CARBONATE HARDNESS		MG/L	32.58
MAGNESIUM NON-CARBONATE HARDNESS		MG/L	79.32
PH	PH UNITS		6.64
EQUILIBRIUM PH (PHS)	PH UNITS		7.36
STABILITY INDEX	PH UNITS		8.08
SATURATION INDEX	PH UNITS		-0.72
TEMPERATURE	DEGREES FAHRENHEIT		68.00
CONDUCTIVITY, MEASURED	MICROMHOS/CM		776.00
IONIC STRENGTH (MOLAR)			0.0120
ION BALANCE ERROR (PERCENT) BY CONCENTRATION			1.91

STANDARD CHEMICAL WATER ANALYSIS
SAMPLE: OWC-6 CHEVRON

CATIONS			LABORATORY ANALYSIS
CALCIUM	CA+2	MG/L	93.00
IRON, TOTAL	FE+2	MG/L	2.00
MAGNESIUM	MG+2	MG/L	34.00
MANGANESE	MN+2	MG/L	6.50
POTASSIUM	K +1	MG/L	1.30
SODIUM	NA+1	MG/L	33.00

ANIONS

BICARBONATE	HCO3-1	MG/L	134.13
CARBONATE	CO3 -2	MG/L	0.03
CHLORIDE	CL -1	MG/L	104.00
FLUORIDE	F -1	MG/L	0.21
HYDROXIDE	OH -1	MG/L	0.00
NITRATE	NO3 -1	MG/L	3.59
PHOSPHATE	PO4 -3	MG/L	0.00
SULFATE	SO4 -2	MG/L	133.00
SILICATE	SI04-4	MG/L	0.02

SILICA	SI02	MG/L	34.24
TOTAL FREE CARBON DIOXIDE	CO2	MG/L	188.59
EQUILIBRIUM CARBON DIOXIDE	CO2	MG/L	8.72
TOTAL DISSOLVED SOLIDS (CALC)		MG/L	576.82
TOTAL ALKALINITY	AS CAC03	MG/L	109.95
CALCIUM ALKALINITY	AS CAC03	MG/L	109.95
MAGNESIUM ALKALINITY	AS CAC03	MG/L	0.00
SODIUM ALKALINITY	AS CAC03	MG/L	0.00
TOTAL HARDNESS	AS CAC03	MG/L	371.88
CALCIUM HARDNESS	AS CAC03	MG/L	232.50
MAGNESIUM HARDNESS	AS CAC03	MG/L	139.74
NON-CARBONATE HARDNESS	AS CAC03	MG/L	261.93
CALCIUM NON-CARBONATE HARDNESS		MG/L	122.55
MAGNESIUM NON-CARBONATE HARDNESS		MG/L	139.74
PH	PH UNITS		6.39
EQUILIBRIUM PH (PHS)	PH UNITS		7.57
STABILITY INDEX	PH UNITS		8.74
SATURATION INDEX	PH UNITS		-1.18
TEMPERATURE	DEGREES FAHRENHEIT		68.00
CONDUCTIVITY, MEASURED	MICROMHOS/CM		871.00
IONIC STRENGTH (MOLAR)			0.0139
ION BALANCE ERROR (PERCENT) ACTIVITY CORRECTED			-0.17

STANDARD CHEMICAL WATER ANALYSIS
SAMPLE: OWC-7 CHEVRON

CATIONS			LABORATORY ANALYSIS
CALCIUM	CA+2	MG/L	150.00
IRON, TOTAL	FE+2	MG/L	10.50
MAGNESIUM	MG+2	MG/L	62.00
MANGANESE	MN+2	MG/L	25.00
POTASSIUM	K +1	MG/L	6.90
SODIUM	NA+1	MG/L	125.00

ANIONS			
BICARBONATE	HC03-1	MG/L	402.21
CARBONATE	C03 -2	MG/L	0.21
CHLORIDE	CL -1	MG/L	230.00
FLUORIDE	F -1	MG/L	0.35
HYDROXIDE	OH -1	MG/L	0.00
NITRATE	NO3 -1	MG/L	0.89
PHOSPHATE	P04 -3	MG/L	0.77
SULFATE	S04 -2	MG/L	190.00
SILICATE	SI04-4	MG/L	0.03

SILICA	SI02	MG/L	27.82
TOTAL FREE CARBON DIOXIDE	C02	MG/L	364.96
EQUILIBRIUM CARBON DIOXIDE	C02	MG/L	114.30
TOTAL DISSOLVED SOLIDS (CALC)		MG/L	1225.07
TOTAL ALKALINITY	AS CAC03	MG/L	329.94
CALCIUM ALKALINITY	AS CAC03	MG/L	329.94
MAGNESIUM ALKALINITY	AS CAC03	MG/L	0.00
SODIUM ALKALINITY	AS CAC03	MG/L	0.00
TOTAL HARDNESS	AS CAC03	MG/L	629.26
CALCIUM HARDNESS	AS CAC03	MG/L	375.00
MAGNESIUM HARDNESS	AS CAC03	MG/L	254.82
NON-CARBONATE HARDNESS	AS CAC03	MG/L	299.31
CALCIUM NON-CARBONATE HARDNESS		MG/L	45.06
MAGNESIUM NON-CARBONATE HARDNESS		MG/L	254.82
PH	PH UNITS		6.62
EQUILIBRIUM PH (PHS)	PH UNITS		6.91
STABILITY INDEX	PH UNITS		7.20
SATURATION INDEX	PH UNITS		-0.29
TEMPERATURE	DEGREES FAHRENHEIT		68.00
CONDUCTIVITY, MEASURED	MICROMHOS/CM		1704.00
IONIC STRENGTH (MOLAR)			0.0272
ION BALANCE ERROR (PERCENT) ACTIVITY CORRECTED			-2.30

STANDARD CHEMICAL WATER ANALYSIS
SAMPLE: OWC-8 CHEVRON

CATIONS			LABORATORY ANALYSIS
CALCIUM	CA+2	MG/L	171.00
IRON, TOTAL	FE+2	MG/L	0.16
MAGNESIUM	MG+2	MG/L	31.00
MANGANESE	MN+2	MG/L	1.49
POTASSIUM	K +1	MG/L	1.80
SODIUM	NA+1	MG/L	49.00

ANIONS

BICARBONATE	HC03-1	MG/L	450.67
CARBONATE	C03 -2	MG/L	0.36
CHLORIDE	CL -1	MG/L	120.00
FLUORIDE	F -1	MG/L	0.15
HYDROXIDE	OH -1	MG/L	0.00
NITRATE	NO3 -1	MG/L	0.89
PHOSPHATE	PO4 -3	MG/L	0.00
SULFATE	SO4 -2	MG/L	85.00
SILICATE	SI04-4	MG/L	0.05

SILICA	SI02	MG/L	27.82
TOTAL FREE CARBON DIOXIDE	CO2	MG/L	219.03
EQUILIBRIUM CARBON DIOXIDE	CO2	MG/L	172.59
TOTAL DISSOLVED SOLIDS (CALC)		MG/L	931.99
TOTAL ALKALINITY	AS CAC03	MG/L	369.92
CALCIUM ALKALINITY	AS CAC03	MG/L	369.92
MAGNESIUM ALKALINITY	AS CAC03	MG/L	0.00
SODIUM ALKALINITY	AS CAC03	MG/L	0.00
TOTAL HARDNESS	AS CAC03	MG/L	554.15
CALCIUM HARDNESS	AS CAC03	MG/L	427.50
MAGNESIUM HARDNESS	AS CAC03	MG/L	127.41
NON-CARBONATE HARDNESS	AS CAC03	MG/L	184.23
CALCIUM NON-CARBONATE HARDNESS		MG/L	57.58
MAGNESIUM NON-CARBONATE HARDNESS		MG/L	127.41
PH	PH UNITS		6.87
EQUILIBRIUM PH (PHS)	PH UNITS		6.79
STABILITY INDEX	PH UNITS		6.71
SATURATION INDEX	PH UNITS		0.08
TEMPERATURE	DEGREES FAHRENHEIT		68.00
CONDUCTIVITY, MEASURED	MICROMHOS/CM		1202.00
IONIC STRENGTH (MOLAR)			0.0194
ION BALANCE ERROR (PERCENT) BY CONCENTRATION			2.87

STANDARD CHEMICAL WATER ANALYSIS
SAMPLE: OWC-9 CHEVRON

CATIONS				LABORATORY ANALYSIS	
CALCIUM	CA+2	MG/L			69.00
IRON, TOTAL	FE+2	MG/L			0.16
MAGNESIUM	MG+2	MG/L			23.00
MANGANESE	MN+2	MG/L			0.53
POTASSIUM	K +1	MG/L			1.20
SODIUM	NA+1	MG/L			27.00
ANIONS					
BICARBONATE	HCO3-1	MG/L			341.01
CARBONATE	CO3 -2	MG/L			0.29
CHLORIDE	CL -1	MG/L			7.00
FLUORIDE	F -1	MG/L			0.58
HYDROXIDE	OH -1	MG/L			0.00
NITRATE	NO3 -1	MG/L			1.06
PHOSPHATE	PO4 -3	MG/L			0.00
SULFATE	SO4 -2	MG/L			20.00
SILICATE	SI04-4	MG/L			0.03
SILICA		SI02	MG/L		14.98
TOTAL FREE CARBON DIOXIDE		CO2	MG/L		110.26
EQUILIBRIUM CARBON DIOXIDE		CO2	MG/L		44.58
TOTAL DISSOLVED SOLIDS (CALC)			MG/L		500.26
TOTAL ALKALINITY	AS	CAC03	MG/L		279.94
CALCIUM ALKALINITY	AS	CAC03	MG/L		172.50
MAGNESIUM ALKALINITY	AS	CAC03	MG/L		94.53
SODIUM ALKALINITY	AS	CAC03	MG/L		13.18
TOTAL HARDNESS	AS	CAC03	MG/L		266.75
CALCIUM HARDNESS	AS	CAC03	MG/L		172.50
MAGNESIUM HARDNESS	AS	CAC03	MG/L		94.53
NON-CARBONATE HARDNESS	AS	CAC03	MG/L		0.00
CALCIUM NON-CARBONATE HARDNESS			MG/L		0.00
MAGNESIUM NON-CARBONATE HARDNESS			MG/L		0.00
PH	PH	UNITS			7.01
EQUILIBRIUM PH (PHS)	PH	UNITS			7.27
STABILITY INDEX	PH	UNITS			7.53
SATURATION INDEX	PH	UNITS			-0.26
TEMPERATURE	DEGREES	FAHRENHEIT			68.00
CONDUCTIVITY, MEASURED		MICROMHOS/CM			568.00
IONIC STRENGTH (MOLAR)					0.0093
ION BALANCE ERROR (PERCENT) BY CONCENTRATION					2.37

STANDARD CHEMICAL WATER ANALYSIS
SAMPLE: OWC-10 CHEVRON

CATIONS

LABORATORY
ANALYSIS

CALCIUM	CA+2	MG/L	79.00
IRON, TOTAL	FE+2	MG/L	6.50
MAGNESIUM	MG+2	MG/L	33.00
MANGANESE	MN+2	MG/L	4.30
POTASSIUM	K +1	MG/L	1.50
SODIUM	NA+1	MG/L	68.00

ANIONS

BICARBONATE	HC03-1	MG/L	256.05
CARBONATE	CO3 -2	MG/L	0.08
CHLORIDE	CL -1	MG/L	100.00
FLUORIDE	F -1	MG/L	0.25
HYDROXIDE	OH -1	MG/L	0.00
NITRATE	NO3 -1	MG/L	0.44
PHOSPHATE	PO4 -3	MG/L	4.91
SULFATE	SO4 -2	MG/L	95.00
SILICATE	SI04-4	MG/L	0.02

SILICA	SI02	MG/L	32.10
TOTAL FREE CARBON DIOXIDE	CO2	MG/L	287.02
EQUILIBRIUM CARBON DIOXIDE	CO2	MG/L	26.92
TOTAL DISSOLVED SOLIDS (CALC)		MG/L	676.96
TOTAL ALKALINITY	AS CAC03	MG/L	209.95
CALCIUM ALKALINITY	AS CAC03	MG/L	197.50
MAGNESIUM ALKALINITY	AS CAC03	MG/L	12.45
SODIUM ALKALINITY	AS CAC03	MG/L	0.00
TOTAL HARDNESS	AS CAC03	MG/L	332.83
CALCIUM HARDNESS	AS CAC03	MG/L	197.50
MAGNESIUM HARDNESS	AS CAC03	MG/L	135.63
NON-CARBONATE HARDNESS	AS CAC03	MG/L	122.89
CALCIUM NON-CARBONATE HARDNESS		MG/L	0.00
MAGNESIUM NON-CARBONATE HARDNESS		MG/L	123.18
PH	PH UNITS		6.49
EQUILIBRIUM PH (PHS)	PH UNITS		7.36
STABILITY INDEX	PH UNITS		8.22
SATURATION INDEX	PH UNITS		-0.87
TEMPERATURE	DEGREES FAHRENHEIT		68.00
CONDUCTIVITY, MEASURED	MICROMHOS/CM		871.00
IONIC STRENGTH (MOLAR)			0.0143
ION BALANCE ERROR (PERCENT) ACTIVITY CORRECTED			-2.16

STANDARD CHEMICAL WATER ANALYSIS
SAMPLE: OWC-11 CHEVRON

CATIONS

LABORATORY
ANALYSIS

CALCIUM	CA+2	MG/L	147.00
IRON, TOTAL	FE+2	MG/L	0.15
MAGNESIUM	MG+2	MG/L	44.00
MANGANESE	MN+2	MG/L	6.90
POTASSIUM	K +1	MG/L	0.80
SODIUM	NA+1	MG/L	68.00

ANIONS

BICARBONATE	HCO3-1	MG/L	195.13
CARBONATE	CO3 -2	MG/L	0.04
CHLORIDE	CL -1	MG/L	290.00
FLUORIDE	F -1	MG/L	0.17
HYDROXIDE	OH -1	MG/L	0.00
NITRATE	NO3 -1	MG/L	0.00
PHOSPHATE	PO4 -3	MG/L	0.58
SULFATE	SO4 -2	MG/L	123.00
SILICATE	SI04-4	MG/L	0.01

SILICA	SI02	MG/L	34.24
TOTAL FREE CARBON DIOXIDE	CO2	MG/L	381.41
EQUILIBRIUM CARBON DIOXIDE	CO2	MG/L	27.40
TOTAL DISSOLVED SOLIDS (CALC)		MG/L	906.83
TOTAL ALKALINITY	AS CAC03	MG/L	159.95
CALCIUM ALKALINITY	AS CAC03	MG/L	159.95
MAGNESIUM ALKALINITY	AS CAC03	MG/L	0.00
SODIUM ALKALINITY	AS CAC03	MG/L	0.00
TOTAL HARDNESS	AS CAC03	MG/L	547.74
CALCIUM HARDNESS	AS CAC03	MG/L	367.50
MAGNESIUM HARDNESS	AS CAC03	MG/L	180.84
NON-CARBONATE HARDNESS	AS CAC03	MG/L	387.79
CALCIUM NON-CARBONATE HARDNESS		MG/L	207.55
MAGNESIUM NON-CARBONATE HARDNESS		MG/L	180.84
PH	PH UNITS		6.27
EQUILIBRIUM PH (PHS)	PH UNITS		7.22
STABILITY INDEX	PH UNITS		8.18
SATURATION INDEX	PH UNITS		-0.95
TEMPERATURE	DEGREES FAHRENHEIT		68.00
CONDUCTIVITY, MEASURED	MICROMHOS/CM		1497.00
IONIC STRENGTH (MOLAR)			0.0210
ION BALANCE ERROR (PERCENT) BY CONCENTRATION			0.79

STANDARD CHEMICAL WATER ANALYSIS
SAMPLE: OWC-12 CHEVRON

				LABORATORY ANALYSIS
CATIONS				
CALCIUM	CA+2	MG/L		91.00
IRON, TOTAL	FE+2	MG/L		0.49
MAGNESIUM	MG+2	MG/L		11.60
MANGANESE	MN+2	MG/L		3.30
POTASSIUM	K +1	MG/L		0.90
SODIUM	NA+1	MG/L		38.00
ANIONS				
BICARBONATE	HC03-1	MG/L		279.65
CARBONATE	C03 -2	MG/L		0.37
CHLORIDE	CL -1	MG/L		16.00
FLUORIDE	F -1	MG/L		0.28
HYDROXIDE	OH -1	MG/L		0.00
NITRATE	NO3 -1	MG/L		0.00
PHOSPHATE	PO4 -3	MG/L		0.00
SULFATE	SO4 -2	MG/L		85.00
SILICATE	SI04-4	MG/L		0.12
SILICA		SI02	MG/L	34.24
TOTAL FREE CARBON DIOXIDE		CO2	MG/L	60.67
EQUILIBRIUM CARBON DIOXIDE		CO2	MG/L	38.72
TOTAL DISSOLVED SOLIDS (CALC)			MG/L	556.37
TOTAL ALKALINITY	AS	CAC03	MG/L	229.80
CALCIUM ALKALINITY	AS	CAC03	MG/L	227.50
MAGNESIUM ALKALINITY	AS	CAC03	MG/L	2.30
SODIUM ALKALINITY	AS	CAC03	MG/L	0.00
TOTAL HARDNESS	AS	CAC03	MG/L	274.76
CALCIUM HARDNESS	AS	CAC03	MG/L	227.50
MAGNESIUM HARDNESS	AS	CAC03	MG/L	47.68
NON-CARBONATE HARDNESS	AS	CAC03	MG/L	44.96
CALCIUM NON-CARBONATE HARDNESS			MG/L	0.00
MAGNESIUM NON-CARBONATE HARDNESS			MG/L	45.38
PH	PH	UNITS		7.19
EQUILIBRIUM PH (PHS)	PH	UNITS		7.24
STABILITY INDEX	PH	UNITS		7.30
SATURATION INDEX	PH	UNITS		-0.05
TEMPERATURE	DEGREES	FAHRENHEIT		68.00
CONDUCTIVITY, MEASURED		MICROMHOS/CM		1298.00
IONIC STRENGTH (MOLAR)				0.0108
ION BALANCE ERROR (PERCENT) BY CONCENTRATION				3.36

STANDARD CHEMICAL WATER ANALYSIS
SAMPLE: OWC-13 CHEVRON

CATIONS

CALCIUM	CA+2	MG/L
IRON, TOTAL	FE+2	MG/L
MAGNESIUM	MG+2	MG/L
MANGANESE	MN+2	MG/L
POTASSIUM	K +1	MG/L
SODIUM	NA+1	MG/L

LABORATORY
ANALYSIS

158.00
0.16
34.00
1.37
0.40
57.00

ANIONS

BICARBONATE	HCO3-1	MG/L
CARBONATE	CO3 -2	MG/L
CHLORIDE	CL -1	MG/L
FLUORIDE	F -1	MG/L
HYDROXIDE	OH -1	MG/L
NITRATE	NO3 -1	MG/L
PHOSPHATE	PO4 -3	MG/L
SULFATE	SO4 -2	MG/L
SILICATE	SI04-4	MG/L

176.83
0.04
190.00
0.17
0.00
0.00
0.00
205.00
0.01

SILICA	SI02	MG/L	25.68
TOTAL FREE CARBON DIOXIDE	CO2	MG/L	306.83
EQUILIBRIUM CARBON DIOXIDE	CO2	MG/L	24.30
TOTAL DISSOLVED SOLIDS (CALC)		MG/L	845.76
TOTAL ALKALINITY	AS CAC03	MG/L	144.96
CALCIUM ALKALINITY	AS CAC03	MG/L	144.96
MAGNESIUM ALKALINITY	AS CAC03	MG/L	0.00
SODIUM ALKALINITY	AS CAC03	MG/L	0.00
TOTAL HARDNESS	AS CAC03	MG/L	534.05
CALCIUM HARDNESS	AS CAC03	MG/L	395.00
MAGNESIUM HARDNESS	AS CAC03	MG/L	139.74
NON-CARBONATE HARDNESS	AS CAC03	MG/L	389.10
CALCIUM NON-CARBONATE HARDNESS		MG/L	250.04
MAGNESIUM NON-CARBONATE HARDNESS		MG/L	139.74
PH	PH UNITS		6.32
EQUILIBRIUM PH (PHS)	PH UNITS		7.23
STABILITY INDEX	PH UNITS		8.15
SATURATION INDEX	PH UNITS		-0.91
TEMPERATURE	DEGREES FAHRENHEIT		68.00
CONDUCTIVITY, MEASURED	MICROMHOS/CM		1344.00
IONIC STRENGTH (MOLAR)			0.0204
ION BALANCE ERROR (PERCENT) BY CONCENTRATION			2.68

STANDARD CHEMICAL WATER ANALYSIS
SAMPLE: OWC-14 CHEVRON

CATIONS			LABORATORY ANALYSIS
CALCIUM	CA+2	MG/L	96.00
IRON, TOTAL	FE+2	MG/L	0.06
MAGNESIUM	MG+2	MG/L	19.10
MANGANESE	MN+2	MG/L	0.43
POTASSIUM	K +1	MG/L	4.00
SODIUM	NA+1	MG/L	55.00

ANIONS

BICARBONATE	HCO3-1	MG/L	365.32
CARBONATE	CO3 -2	MG/L	0.31
CHLORIDE	CL -1	MG/L	51.00
FLUORIDE	F -1	MG/L	0.19
HYDROXIDE	OH -1	MG/L	0.00
NITRATE	NO3 -1	MG/L	1.28
PHOSPHATE	PO4 -3	MG/L	0.34
SULFATE	SO4 -2	MG/L	80.00
SILICATE	SIO4-4	MG/L	0.06

SILICA		SIO2	MG/L	27.82
TOTAL FREE CARBON DIOXIDE		CO2	MG/L	134.25
EQUILIBRIUM CARBON DIOXIDE		CO2	MG/L	67.67
TOTAL DISSOLVED SOLIDS (CALC)			MG/L	694.92
TOTAL ALKALINITY	AS	CACO3	MG/L	299.90
CALCIUM ALKALINITY	AS	CACO3	MG/L	240.00
MAGNESIUM ALKALINITY	AS	CACO3	MG/L	59.90
SODIUM ALKALINITY	AS	CACO3	MG/L	0.00
TOTAL HARDNESS	AS	CACO3	MG/L	318.08
CALCIUM HARDNESS	AS	CACO3	MG/L	240.00
MAGNESIUM HARDNESS	AS	CACO3	MG/L	78.50
NON-CARBONATE HARDNESS	AS	CACO3	MG/L	18.18
CALCIUM NON-CARBONATE HARDNESS			MG/L	0.00
MAGNESIUM NON-CARBONATE HARDNESS			MG/L	18.60
PH		PH	UNITS	6.97
EQUILIBRIUM PH (PHS)		PH	UNITS	7.11
STABILITY INDEX		PH	UNITS	7.26
SATURATION INDEX		PH	UNITS	-0.14
TEMPERATURE	DEGREES	FAHRENHEIT		68.00
CONDUCTIVITY, MEASURED		MICROMHOS/CM		842.00
IONIC STRENGTH (MOLAR)				0.0130
IDN BALANCE ERROR (PERCENT) BY CONCENTRATION				-1.50

STANDARD CHEMICAL WATER ANALYSIS
SAMPLE: OWC-15 CHEVRON

CATIONS			LABORATORY ANALYSIS
CALCIUM	CA+2	MG/L	32.00
IRON, TOTAL	FE+2	MG/L	0.53
MAGNESIUM	MG+2	MG/L	10.60
MANGANESE	MN+2	MG/L	0.16
POTASSIUM	K +1	MG/L	0.40
SODIUM	NA+1	MG/L	11.50

ANIONS

BICARBONATE	HCO3-1	MG/L	36.57
CARBONATE	CO3 -2	MG/L	0.00
CHLORIDE	CL -1	MG/L	32.00
FLUORIDE	F -1	MG/L	0.13
HYDROXIDE	OH -1	MG/L	0.00
NITRATE	NO3 -1	MG/L	7.97
PHOSPHATE	PO4 -3	MG/L	0.00
SULFATE	SO4 -2	MG/L	55.00
SILICATE	SI04-4	MG/L	0.01

SILICA	SI02	MG/L	38.52
TOTAL FREE CARBON DIOXIDE	CO2	MG/L	67.20
EQUILIBRIUM CARBON DIOXIDE	CO2	MG/L	0.25
TOTAL DISSOLVED SOLIDS (CALC)		MG/L	224.80
TOTAL ALKALINITY	AS CAC03	MG/L	29.95
CALCIUM ALKALINITY	AS CAC03	MG/L	29.95
MAGNESIUM ALKALINITY	AS CAC03	MG/L	0.00
SODIUM ALKALINITY	AS CAC03	MG/L	0.00
TOTAL HARDNESS	AS CAC03	MG/L	123.44
CALCIUM HARDNESS	AS CAC03	MG/L	80.00
MAGNESIUM HARDNESS	AS CAC03	MG/L	43.57
NON-CARBONATE HARDNESS	AS CAC03	MG/L	93.49
CALCIUM NON-CARBONATE HARDNESS		MG/L	50.05
MAGNESIUM NON-CARBONATE HARDNESS		MG/L	43.57
PH	PH UNITS		6.23
EQUILIBRIUM PH (PHS)	PH UNITS		8.54
STABILITY INDEX	PH UNITS		10.86
SATURATION INDEX	PH UNITS		-2.31
TEMPERATURE	DEGREES FAHRENHEIT		68.00
CONDUCTIVITY, MEASURED	MICROMHDS/CM		338.00
IONIC STRENGTH (MOLAR)			0.0047
ION BALANCE ERROR (PERCENT) ACTIVITY CORRECTED			-0.26

STANDARD CHEMICAL WATER ANALYSIS
SAMPLE: OWC-16 CHEVRON

CATIONS			LABORATORY ANALYSIS
CALCIUM	CA+2	MG/L	144.00
IRON, TOTAL	FE+2	MG/L	0.41
MAGNESIUM	MG+2	MG/L	41.00
MANGANESE	MN+2	MG/L	2.50
POTASSIUM	K +1	MG/L	2.60
SODIUM	NA+1	MG/L	72.00

ANIONS			
BICARBONATE	HCO3-1	MG/L	548.27
CARBONATE	CO3 -2	MG/L	0.38
CHLORIDE	CL -1	MG/L	190.00
FLUORIDE	F -1	MG/L	0.00
HYDROXIDE	OH -1	MG/L	0.00
NITRATE	NO3 -1	MG/L	0.44
PHOSPHATE	PO4 -3	MG/L	0.31
SULFATE	SO4 -2	MG/L	55.00
SILICATE	SIO4-4	MG/L	0.03

SILICA	SIO2	MG/L	23.54
TOTAL FREE CARBON DIOXIDE	CO2	MG/L	315.62
EQUILIBRIUM CARBON DIOXIDE	CO2	MG/L	213.06
TOTAL DISSOLVED SOLIDS (CALC)		MG/L	1071.50
TOTAL ALKALINITY	AS CACO3	MG/L	449.94
CALCIUM ALKALINITY	AS CACO3	MG/L	360.00
MAGNESIUM ALKALINITY	AS CACO3	MG/L	89.94
SODIUM ALKALINITY	AS CACO3	MG/L	0.00
TOTAL HARDNESS	AS CACO3	MG/L	527.91
CALCIUM HARDNESS	AS CACO3	MG/L	360.00
MAGNESIUM HARDNESS	AS CACO3	MG/L	168.51
NON-CARBONATE HARDNESS	AS CACO3	MG/L	77.98
CALCIUM NON-CARBONATE HARDNESS		MG/L	0.00
MAGNESIUM NON-CARBONATE HARDNESS		MG/L	78.57
PH	PH UNITS		6.80
EQUILIBRIUM PH (PHS)	PH UNITS		6.78
STABILITY INDEX	PH UNITS		6.76
SATURATION INDEX	PH UNITS		0.02
TEMPERATURE	DEGREES FAHRENHEIT		68.00
CONDUCTIVITY, MEASURED	MICROMHOS/CM		1610.00
IONIC STRENGTH (MOLAR)			0.0206

STANDARD CHEMICAL WATER ANALYSIS
SAMPLE: OWC-17 CHEVRON

CATIONS

LABORATORY
ANALYSIS

CALCIUM	CA+2	MG/L	162.00
IRON, TOTAL	FE+2	MG/L	5.80
MAGNESIUM	MG+2	MG/L	38.00
MANGANESE	MN+2	MG/L	27.50
POTASSIUM	K +1	MG/L	3.10
SODIUM	NA+1	MG/L	106.00

ANIONS

BICARBONATE	HCO3-1	MG/L	512.06
CARBONATE	CO3 -2	MG/L	0.19
CHLORIDE	CL -1	MG/L	320.00
FLUORIDE	F -1	MG/L	0.00
HYDROXIDE	OH -1	MG/L	0.00
NITRATE	NO3 -1	MG/L	0.00
PHOSPHATE	PO4 -3	MG/L	0.00
SULFATE	SO4 -2	MG/L	80.00
SILICATE	SIO4-4	MG/L	0.03

SILICA		SIO2	MG/L	38.52
TOTAL FREE CARBON DIOXIDE		CO2	MG/L	605.05
EQUILIBRIUM CARBON DIOXIDE		CO2	MG/L	202.57
TOTAL DISSOLVED SOLIDS (CALC)			MG/L	1284.80
TOTAL ALKALINITY	AS	CACO3	MG/L	419.94
CALCIUM ALKALINITY	AS	CACO3	MG/L	405.00
MAGNESIUM ALKALINITY	AS	CACO3	MG/L	14.94
SODIUM ALKALINITY	AS	CACO3	MG/L	0.00
TOTAL HARDNESS	AS	CACO3	MG/L	560.48
CALCIUM HARDNESS	AS	CACO3	MG/L	405.00
MAGNESIUM HARDNESS	AS	CACO3	MG/L	156.18
NON-CARBONATE HARDNESS	AS	CACO3	MG/L	140.55
CALCIUM NON-CARBONATE HARDNESS			MG/L	0.00
MAGNESIUM NON-CARBONATE HARDNESS			MG/L	141.24
PH	PH	UNITS		6.50
EQUILIBRIUM PH (PHS)	PH	UNITS		6.77
STABILITY INDEX	PH	UNITS		7.04
SATURATION INDEX	PH	UNITS		-0.27
TEMPERATURE	DEGREES	FAHRENHEIT		68.00
CONDUCTIVITY, MEASURED		MICROMHOS/CM		2000.00
IONIC STRENGTH (MOLAR)				0.0251

STANDARD CHEMICAL WATER ANALYSIS
SAMPLE: OWC-18 CHEVRON

CATIONS

LABORATORY
ANALYSIS

CALCIUM	CA+2	MG/L	77.00
IRON, TOTAL	FE+2	MG/L	0.97
MAGNESIUM	MG+2	MG/L	15.20
MANGANESE	MN+2	MG/L	0.06
POTASSIUM	K +1	MG/L	3.70
SODIUM	NA+1	MG/L	12.80

ANIONS

BICARBONATE	HC03-1	MG/L	290.93
CARBONATE	C03 -2	MG/L	0.74
CHLORIDE	CL -1	MG/L	16.00
FLUORIDE	F -1	MG/L	0.00
HYDROXIDE	OH -1	MG/L	0.01
NITRATE	NO3 -1	MG/L	0.00
PHOSPHATE	PO4 -3	MG/L	0.00
SULFATE	SO4 -2	MG/L	33.00
SILICATE	SIO4-4	MG/L	0.20

SILICA		SIO2	MG/L	27.82
TOTAL FREE CARBON DIOXIDE		CO2	MG/L	30.31
EQUILIBRIUM CARBON DIOXIDE		CO2	MG/L	36.65
TOTAL DISSOLVED SOLIDS (CALC)			MG/L	473.66
TOTAL ALKALINITY	AS	CAC03	MG/L	239.67
CALCIUM ALKALINITY	AS	CAC03	MG/L	192.50
MAGNESIUM ALKALINITY	AS	CAC03	MG/L	47.17
SODIUM ALKALINITY	AS	CAC03	MG/L	0.00
TOTAL HARDNESS	AS	CAC03	MG/L	254.63
CALCIUM HARDNESS	AS	CAC03	MG/L	192.50
MAGNESIUM HARDNESS	AS	CAC03	MG/L	62.47
NON-CARBONATE HARDNESS	AS	CAC03	MG/L	14.96
CALCIUM NON-CARBONATE HARDNESS			MG/L	0.00
MAGNESIUM NON-CARBONATE HARDNESS			MG/L	15.30
PH	PH	UNITS		7.50
EQUILIBRIUM PH (PHS)	PH	UNITS		7.29
STABILITY INDEX	PH	UNITS		7.08
SATURATION INDEX	PH	UNITS		0.21
TEMPERATURE	DEGREES	FAHRENHEIT		68.00
CONDUCTIVITY, MEASURED		MICROMHOS/CM		622.00
IONIC STRENGTH (MOLAR)				0.0088
ION BALANCE ERROR (PERCENT) BY CONCENTRATION				-1.32

APPENDIX D

APPENDIX D

CALCULATION OF CONTAMINANT FLUX

The velocity of groundwater flowing through a plane of soil as shown in Figure D-1 is defined as the Darcian or approach velocity:

$$(1) \quad V_d = Ki$$

where V_d = velocity (feet per second)
 K = coefficient of soil permeability
(feet per second)
 i = hydraulic gradient of the groundwater
(feet/feet)

Because the soil consists of solids and voids, and the water can only pass through the voids, the actual velocity of the groundwater in voids, i.e., pore water velocity, V_p , is defined as:

$$(2) \quad V_p = \frac{Ki}{n}$$

where n = is the effective soil porosity

The effective soil porosity is defined as percentage of interconnected voids which exist in a volume of soil. A porosity of zero indicates the material is impermeable; a porosity of 1.0 indicates 100 percent voids. Typical values of porosity range from 0.15 to 0.40.

The rate at which groundwater is flowing across a plane of soil is defined by:

$$(3) \quad Q = KiA$$

where K and i have been previously defined
 A = area through which groundwater is
flowing (feet²)
 Q = rate of groundwater movement
 $\frac{\text{feet}^3}{\text{sec}}$

The total volume of groundwater moving across a soil plane in a specified period of time is defined by:

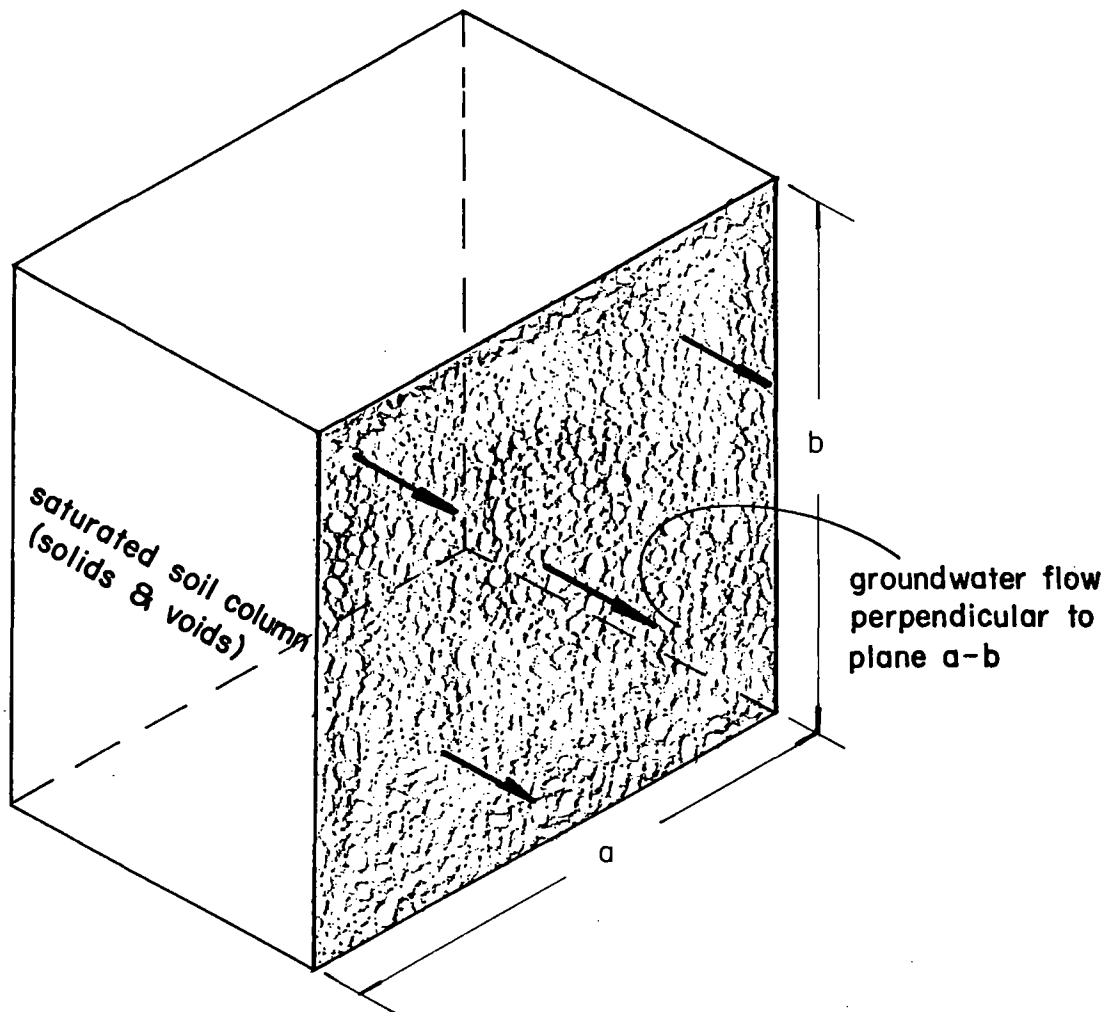
$$(4) \quad V = Qt$$

where V = volume of groundwater (feet³)
 Q = rate of groundwater flow (feet³/sec)
 t = time in seconds

If the groundwater has a constant constituent concentration during the specified time period or if the concentration varies and an average constituent concentration can be determined, then the quantity, by weight, of the constituent transported by the groundwater across the soil plane can be estimated by:

$$(5) \quad W = V \times c \times 8.34 \frac{\text{lbs}}{\text{gal}}$$

where W = weight of constituent transported
in a specified time period (pounds)
 V = volume of groundwater moving across a
soil plane in specified time period
(million gallons)
 c = concentration of constituent during
the time period (parts per million or
milligrams per liter)



Area = a x b

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HYDROGEOLOGY STUDY & GROUNDWATER CHARACTERISTICS
MARYLAND HEIGHTS, MISSOURI
ORTHO-CHEVRON CHEMICAL COMPANY

PROJECT NO.

S 81-5-2

WOODWARD-CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS
CENTRAL REGION

DRN. BY: *GM* 11-23-81
CHKD. BY: *PSK*

GROUNDWATER FLOW SCHEMATIC

FIG. NO.
D-1